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PARACHUTE RIGGER 1 & C

NAVY TRAINING COURSES

PARACHUTE RIGGER
1 & C

U.S., Prepared By

BUREAU OF NAVAL PERSONNEL

NAVY TRAINING COURSES

NAVPERS 10360

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON: 1959

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington 25, D.C. - Price $1.75.

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THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

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PREFACE

This Navy Training Course is one of a series of training courses prepared for enlisted personnel of the Navy and of the Naval Reserve who are studying for advancement in the Parachute Rigger rating.

As indicated by the title, this training course is based primarily on the professional qualifications for the rates of PR1 and PRC, as set forth in the *Manual of Qualifications for Advancement in Rating*, NavPers 18068. These qualifications, current as of the date of Change 12 to the "Quals" Manual, are listed in appendix II of this book.

Combined with the necessary practical experience and a thorough knowledge of the material contained in *Parachute Rigger 3 and 2*, a study of the material in this course will greatly assist the PR2 and PR1 in preparing for advancement. This material should also be valuable as a review source for the PRC who is studying for advancement to PRCS and the PRCS in studying for PRCM.

This training course was prepared by the U. S. Navy Training Publications Center, Memphis, Tennessee, in conjunction with the Training Division of the Bureau of Naval Personnel. Credit is given to the staff of the Parachute Rigger Schools, NATTU, Lakehurst, New Jersey, for reviewing the manuscript and supplying the end-of-chapter questions.

READING LIST

Parachute Rigger 3 and 2, Volume 1, NavPers 10358
Parachute Rigger 3 and 2, Volume 2, NavPers 10359
Military Requirements for Petty Officer 1 and C, NavPers 10057
Safety and Survival Equipment for Naval Aviation, NavAer 00-80T-52
Parachute Manual, NavAer 13-5-501

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ACTIVE DUTY ADVANCEMENT REQUIREMENTS

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<tr><td>SCHOOL</td><td>Recruit Training.</td><td></td><td>Class A for PR3, PRS3.</td><td></td><td>Class B for MN1.</td><td>Class B for AGCA, MNCA, MUCA.</td></tr>
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<tr><td>PRACTICAL FACTORS</td><td>Locally prepared check-offs.</td><td colspan="5">Records of Practical Factors, NavPers 760, must be completed for E–3 and all PO advancements.</td></tr>
<tr><td>PERFORMANCE TEST</td><td colspan="2"></td><td colspan="4">Specified ratings must complete applicable performance tests before taking examinations.</td></tr>
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<tr><td>NAVY TRAINING COURSE (INCLUDING MILITARY REQUIREMENTS)</td><td></td><td colspan="5">Required for E–3 and all PO advancements unless waived because of school completion, but need not be repeated if identical course has already been completed.</td></tr>
<tr><td rowspan="2">AUTHORIZATION</td><td colspan="2">Commanding Officer</td><td colspan="3">U. S. Naval Examining Center</td><td>BuPers</td></tr>
<tr><td colspan="6">TARS are advanced to fill vacancies and must be approved by district commandants or CNARESTRA.</td></tr>
</table>

*Recommendation of petty officers, officers and approval by commanding officer required for all advancements.

INACTIVE DUTY ADVANCEMENT REQUIREMENTS

REQUIREMENTS*		E1 to E2	E2 to E3	E3 to E4	E4 to E5	E5 to E6	E6 to E7A
	FOR THESE DRILLS PER YEAR						
TOTAL TIME IN GRADE	24 OR 48	9 mos.	9 mos.	15 mos.	18 mos.	24 mos.	36 mos.
	12	9 mos.	15 mos.	21 mos.	24 mos.	36 mos.	42 mos.
	NON-DRILLING	12 mos.	24 mos.	24 mos.	36 mos.	48 mos.	48 mos.
DRILLS ATTENDED IN GRADE#	48	27	27	45	54	72	108
	24	16	16	27	32	42	64
	12	8	13	18	20	32	38
TOTAL TRAINING DUTY IN GRADE#	24 OR 48	14 days	14 days	14 days	14 days	28 days	42 days
	12	14 days	14 days	14 days	28 days	42 days	42 days
	NON-DRILLING	None	None	14 days	14 days	28 days	28 days
PERFORMANCE TESTS				Specific ratings must complete applicable performance tests before taking examination.			
PRACTICAL FACTORS (INCLUDING MILITARY REQUIREMENTS)		Record of Practical Factors, NavPers 1316, must be completed for all advancements.					
NAVY TRAINING COURSE (INCLUDING MILITARY REQUIREMENTS)		Completion of applicable course or courses must be entered in service record.					
EXAMINATION		Standard exams are used where available, otherwise locally prepared exams are used.					
AUTHORIZATION		District commandant or CNARESTRA					BuPers

*Recommendation of petty officers, officers and approval by commanding officer required for all advancements.

#Active duty periods may be substituted for drills and training duty.

PARACHUTE RIGGER

1 & C

CHAPTER 1

INTRODUCTION

RESPONSIBILITIES OF THE PR1 AND PRC

As a petty officer, you are already aware of the importance of your rating to the Navy. Since the day you became a PR striker, your primary responsibility has been that of saving lives. You are well aware that without the services performed by the men of the PR rating none of the Navy's air operations could be safely conducted, and with today's high-speed, high-altitude aircraft, the Parachute Rigger's job is more important than ever before.

As higher and higher aircraft speeds and altitudes are attained, new items of flight and protective clothing and survival equipment are developed. Thus, the Parachute Rigger's job involves more and more responsibilities, and from the lowest level up, the Parachute Rigger must possess greater technical skills than ever before.

Now that you are ready for advancement to PR1, or PRC, even more responsibilities are to be yours. As a senior Parachute Rigger you must possess more than technical skills. You must assume greater responsibility, not only for your work but also for the work of others who serve under you. Briefly, the senior Parachute Rigger must be a master technician, military leader, supervisor, inspector, and instructor.

As a PR1 you must be qualified to fit and adjust anti-g suits; maintain and test pressure suits and related equipment; operate and maintain oxygen transfer equipment; shop test liquid oxygen converters and repair or replace components as necessary; test oxygen for contamination; test and maintain oxygen regulators; and maintain carbon dioxide recharge equipment. In addition, the PR1 must maintain records, prepare reports, and inventory and order equipment, spare parts, and other materials. Finally, the PR1 must be capable of taking charge in the absence of the PRC.

As a PRC you must be qualified to fit and modify oxygen masks; prepare calibration and flow charts for testing oxygen regulators and converters; maintain regulator test stands and liquid oxygen converter test stands; demonstrate aircraft emergency escape procedures; assemble, pack, and rig air drop survival kits and containers; and construct various types of lift webs and sling assemblies. In addition, the PRC must be fully qualified to organize and administer a parachute loft; plan, schedule, and direct work assignments; and maintain quality control of all work performed.

The preceding is a brief summary of the requirements for advancement to First Class and Chief Parachute Rigger. Detailed requirements are listed in appendix II of this book.

ASSIGNMENTS AVAILABLE TO PR1 AND PRC

As a senior Parachute Rigger, a wider variety of assignments will be available to you. In addition to the various types of maintenance activities to which lower rated PR's are assigned (operating squadron, service squadron, naval air station, and ship), senior PR's are eligible for assignment to various experimental and test facilities, as well as a number of billets under the management control of the Bureau of Naval Personnel.

Parachute Riggers are assigned to experimental and test facilities to assist in the work of testing and evaluating newly developed items of equipment. These units determine the suitability of equipment prior to its use in the fleet. Examples of such units are the Navy Parachute Experimental Division at El Centro, California, and the Air Crew Equipment Laboratory at Philadelphia, Pennsylvania.

Most of the billets under the management control of the Bureau of Naval Personnel are directly associated with training. Some of those available to senior Parachute Riggers are described below. Others are announced from time to time in the form of series 1300 *BuPers Instructions*.

Instructor billets are available to both the PR1 and PRC in the PR (Class A and B) Schools. Instructor billets are normally filled on a voluntary basis. Personnel selected from the volunteer list are first sent to Instructor School for a 4-week course in instructor training.

PRC's are eligible for assignment to the Navy Training Publications Center at Memphis, Tennessee, as technical advisors. Technical advisors assist in the preparation and revision of Navy Training Courses and other training materials.

Another billet available to PRC's is with the Naval Examining Center at Great Lakes, Illinois, as item writer. In this billet, PRC's assist in the preparation of servicewide advancement-in-rate examinations for the PR rating.

REFERENCES USED IN PREPARING FOR ADVANCEMENT

Manual of Qualifications for Advancement in Rating, NavPers 18068 (Revised)

This manual, commonly referred to as the "Quals" Manual, is the official publication which sets forth the minimum qualifications for advancement in rating of all enlisted personnel in the Navy. The Quals Manual serves as a guide for (1) enlisted men in preparing for advancement in rating, (2) preparation of training courses and school curricula, and (3) preparation of servicewide advancement-in-rating examinations. The manual is kept up-to-date to meet the needs of the Service by CHANGES to the Manual, issued periodically by the Bureau of Naval Personnel.

The Quals Manual is composed of two main sections, titled Military Requirements and Professional Qualifications.

MILITARY REQUIREMENTS.—This section contains those generally applicable qualifications which all enlisted personnel are expected to demonstrate as a minimum for advancement to specific pay grades. They are applicable to all personnel at the specified pay grade except where indicated for men or women only.

The military requirements are broken down into practical factors and examination subjects. Candidates for advancement in any pay grade must demonstrate proficiency in the practical factors specified for the next higher pay grade, and may be required to demonstrate those for all lower pay grades. Knowledges essential to performance of the practical factors as well as those essential to the required examination subjects are subject to examination for advancement.

PROFESSIONAL QUALIFICATIONS.—This section contains the professional requirements for advancement in each rating. The professional qualifications for the Parachute Rigger are broken down into subject matter areas, and each subject matter area is further broken down into practical factors and knowledge factors. Practical factors must be completed before recommendation for participation in the servicewide examinations. Knowledge factors and knowledge aspects of the practical factors form the basis for questions in the written advancement examinations. Qualifications for a higher rate include the qualifications of the lower rate or rates in addition to those stated for the higher rate.

The professional qualifications for the Parachute Rigger rating are listed in appendix II of this training course, current as of the date of Change 12 to the Quals Manual. Before using these qualifications as a guide in studying for advancement, always make sure that no further changes affecting the PR rating have been issued. If in doubt, check the official copy of the *Manual of Qualifications for Advancement in Rating* in your education office.

Record of Practical Factors

A standard method of maintaining a record of each enlisted man's progress on the practical factors of his rating was established with the issue of *BuPers Instruction 1085.38.* As directed by this Instruction, an appropriate *Record of Practical Factors,* NavPers Form 760, is to be maintained by each command for each enlisted man in pay grades E-3 through E-6.

Completion of the practical factors for the rate to which the man is advancing is required prior to actual participation in the servicewide examination. As proficiency in each practical factor listed on the form is demonstrated, an entry is made in the "Date" and "Initials" columns of the form by the supervising officer.

All factors for which facilities are available must be completed by actual demonstration. At commands where facilities are not available for proper demonstration of certain practical factors, personnel may be qualified in those factors by local written examinations.

If a man demonstrates proficiency in skills considered to be within the scope of his rating but not listed in the list of minimum qualifications, an appropriate entry is made on his form.

One copy of this form is to be held by the division officer or by the appropriate supervising officer of each man in pay grade E-3 through E-6. Upon transfer, the supervising officer's copy of the form is signed, inserted in the correspondence side of the man's service record, and forwarded.

As changes in the rating structure and major changes in the Quals Manual occur, new forms are made available. Minor changes in the Quals Manual are recorded on existing forms in the spaces provided.

One copy of the printed form is made available to each man for his personal record and guidance.

Training Publications for Advancement in Rating, NavPers 10052

This booklet lists Navy Training Courses and other publications required or recommended for study in preparing for advancement. It is revised and reissued annually by the Bureau of Naval Personnel and is the official bibliography of reference sources from which examination questions are taken. Training courses which are marked with an asterisk must be completed for the specific rates listed before candidates are eligible to take servicewide examinations.

Navy Training Courses

Navy Training Courses are of three general types, each designed to aid the enlisted man in preparing for advancement in rating. They are classed as General Courses, Basic Courses, and Rating Courses.

GENERAL COURSES.—General courses cover the military requirements specifically required of all petty officers. Included as mandatory reading in this group are *Military Requirements for Petty Officer 1 and C,* NavPers 10057, and *Military Requirements for Petty Officer 3 and 2,* NavPers 10056. Certain chapters of several other general courses are listed as recommended reading. For this listing, refer to the current edition of *Training Publications for Advancement in Rating,* NavPers 10052.

BASIC COURSES.—These courses are sometimes referred to as subject matter courses. They cover such fundamental subjects as blueprint reading, mathematics, handtools, basic electricity, hydraulics, and the like. In other words, subjects which are useful to more than one rating are covered in this group. Among those of interest to the Parachute Rigger are *Blueprint Reading and Sketching,* NavPers 10077-A, and *Basic Hand Tool Skills,* NavPers 10085.

RATING COURSES.—Rating courses cover the professional qualifications for a specific rate or rates, using the Quals Manual as a guide. This means that each qualification in the Quals Manual (practical factor and knowledge factor) is covered either by adequate material in the rating book itself, by reference to a basic course, or by reference to some other satisfactory and readily available publication.

Rating courses are revised from time to time to keep pace with new developments in equipment as well as to comply with changes to the rating structure in the Quals Manual. In studying for advancement, always check the current edition of *Training Publications for Advancement in Rating,* NavPers 10052, for the date of the latest issue of your rating course or courses.

This Training Course

This training course is based on the professional qualifications for the rates of PR1 and PRC, as set forth in the Quals Manual (effective as of the date of Change 12). It is designed primarily for use by the PR2 who is studying for advancement to PR1, and the PR1 who is studying for

PRC. Much of the material in this course should also be valuable as a review source for the PRC who is studying for advancement to PRCS and the PRCS in studying for PRCM.

Chapter 2 deals mainly with the administrative duties of the PRC; for example, setting up and organizing a parachute loft; procurement of materials and equipment; maintenance of records and reports; procurement and use of aeronautical publications; training of loft personnel; and instructing pilots and aircrewmen in the proper use of flight clothing and survival equipment. Chapter 3 covers the various methods of testing oxygen for contamination, describing the use of halide detectors, purity analyzers, and water vapor indicators. The next four chapters deal with the testing and repair of oxygen regulators and converters and the operation and maintenance of test equipment. Chapter 8 covers maintenance of carbon dioxide recharge equipment, and chapter 9 relates to aerial delivery. Chapter 10 deals with pressure suits and related equipment, chapter 11 with sewing machine repairs.

Some suggestions for studying this training course are presented in the following paragraphs.

First, turn to appendix II and make a list of your applicable requirements. Next, turn to the table of contents in the front of the book, taking note of the chapters you feel you need to study. Study the index in the back of the book, taking note of specific items you need to study.

Study the material by chapters, mastering the subject matter of one before proceeding to another. When you feel that you have mastered the applicable material of a chapter, turn to the end-of-chapter quiz. Each quiz is composed of multiple-choice items, similar to those found on the servicewide examinations. There is only one BEST answer for each test item. Mark your choices on a separate sheet, then check them with the correct answers listed in appendix I.

If some of your answers are incorrect, find out the reason. Perhaps you misunderstood the test item, or it could be that you failed to master the text material. In taking this type of quiz, a careful reading of each test item is especially important.

After you are satisfied with your mastery of the applicable material of one chapter, proceed to the next.

From time to time review the material that you have already studied; this will enable you to retain it clearly and accurately with a minimum of restudy. Continue the chapter-by-chapter study until you have mastered the entire course.

QUIZ

1. In order to determine which Navy Training Courses are mandatory reading for the PR rating, reference should be made to
   a. NavAer 00-500
   b. NavAer 00-500A
   c. NavPers 760(PR)
   d. NavPers 10052
2. The Manual of Qualifications for Advancement in Rating is designed to be used as a guide in the preparation of all
   a. servicewide examinations
   b. Navy Training Courses
   c. school curricula
   d. the above
3. Navy Training Courses are of_____ general types.
   a. 2
   b. 3
   c. 4
   d. 5
4. Fundamental subjects such as blueprint reading, mathematics, and handtools are covered in ____________ Navy Training Courses.
   a. basic
   b. general
   c. rating
   d. USAFI
5. A Record of Practical Factors must be maintained by each command for each enlisted man in pay grades E-3 through E-9.
   a. True
   b. False
6. The Manual of Qualifications for Advancement in Rating is made up of two main sections. They are titled
   a. practical factors and examination subjects
   b. practical factors and knowledge factors
   c. military requirements and professional qualifications
   d. general requirements and special qualifications

7. When using the *Manual of Qualifications for Advancement in Rating* as a guide in preparing for forthcoming examinations, always make sure that
    a. the latest Change issued by BuPers has been incorporated
    b. a letter of promulgation is contained therein
    [✓ c.] all requirements listed in 00-500 are incorporated
    d. the requirements for all emergency service ratings are incorporated
8. The bibliography of reference sources from which examination questions are taken (NavPers 10052) is revised and reissued
    a. quarterly
    b. semiannually
    c. annually
    d. only when changes to the enlisted rating structure have been made

CHAPTER 2

THE PARACHUTE LOFT

PARACHUTE LOFT AFLOAT

The CVA parachute loft, like most of the other shops afloat, is extremely limited in size. In order to accomplish the vast amount of work that flows through an establishment of this kind, everyone concerned must cooperate by adhering to a well-planned schedule.

The greater portion of the space provided is occupied by three main items. These are packing tables, storage bins, and sewing machines. Modern carriers have an additional space provided for airing and drying parachutes. The justification for this drying space was linked to the need for a more adequate packing schedule. Before this added space for drying parachutes was incorporated, parachutes due to be packed were hung in the inadequate loft space. This jammed the packing schedule to such an extent that the air group squadrons were unable to pack their parachutes during the alloted time. A dry locker permits the parachutes to be cleared out of the loft, allowing a round-the-clock packing schedule when necessary. Figure 2-1 illustrates the physical layout of a typical parachute loft space located on the O2 deck of a CVA type carrier. Air groups using this space are required to help in its maintenance while they are aboard.

CVE and CVL type carriers have very limited facilities aboard for parachute packing. The Parachute Rigger in charge has three alternatives to meet the packing schedule: Messhall tables can be utilized for packing, a lightweight

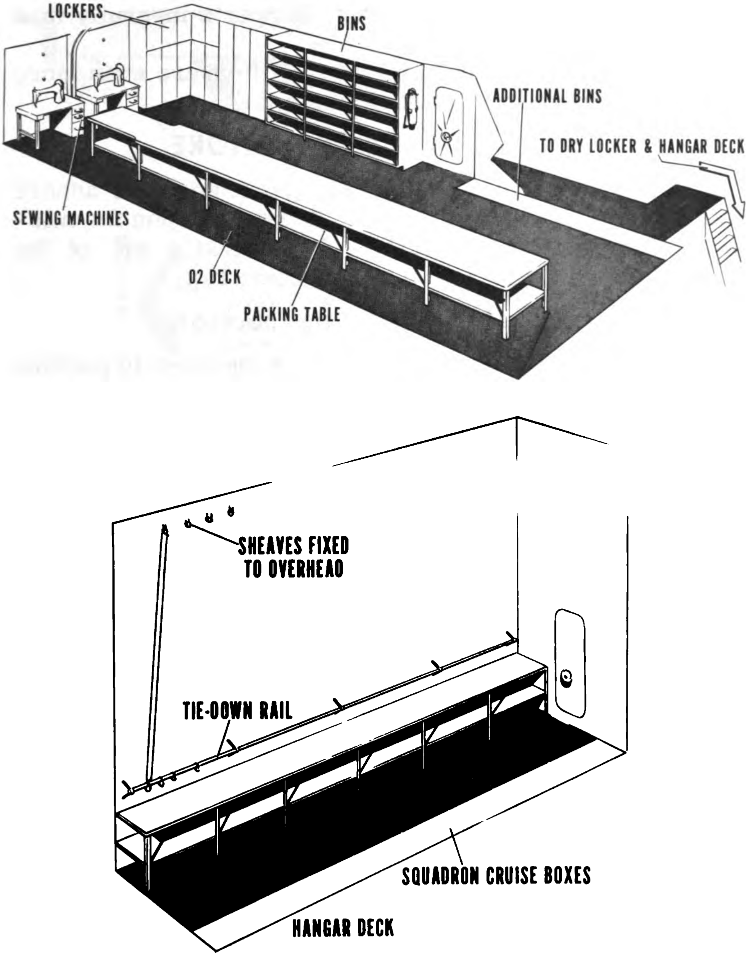


Figure 2-1.—Parachute loft space aboard an aircraft carrier.

plywood sectional packing table can be set up in some clear part of the ship, or shore establishment packing facilities can be used whenever possible. Parachutes and survival equipment are stowed in lockers throughout the ship. There is no assigned working space large enough to carry out the everyday working schedule. The duty aboard a CVE may be classified as a field operation that demands more of the Parachute Rigger's ingenuity than can be related here.

AV and AVP parachute loft facilities are even more limited in accommodations than the CVE.

PARACHUTE LOFT ASHORE

The design and style of the parachute loft ashore varies from activity to activity, depending upon the mission of the station. Figure 2-2 illustrates one of the many floor plans of a typical parachute loft.

Parachute Packing Section

The parachute packing section is devoted to packing and inspecting parachutes. Parachute packing tables naturally occupy the greatest part of the loft. Thorough consideration should be given to the number of tables that can be successfully utilized, allowing ample working space around the tables.

A cutaway table is the least tiring to use, as the packers do not have to stretch across its full width during the closing and finishing of the packing. Figure 2-3 shows the cutaway packing table. The dimensions shown in this illustration are adequate for accommodating the 28-foot service parachute. The tension device for the packing table is extremely simple to make. These devices should be constructed to suit the individual packing needs.

STORAGE BINS.—Storage bins should be constructed so there is enough clearance between the shelves and the sides to allow for easy insertion and removal of parachutes with life raft attached. The bins should be long enough for the parachutes to be placed on a shelf side by side with at least 1 inch clearance on all sides and top. The bottom row of bins should be located at least 12 inches from the deck and all bins 4 inches away from the bulkhead.

WORKLOAD.—A reasonable maximum workload per day for one table is considered to be approximately 25 parachutes. The number of air groups, the parachutes assigned each, and the station equipment will have to be taken into consideration in order to determine the number of tables necessary to adequately carry out the prescribed packing schedule. Many factors determine the workload of a parachute loft. Packing operations should not be interrupted and the area where the tables are located should

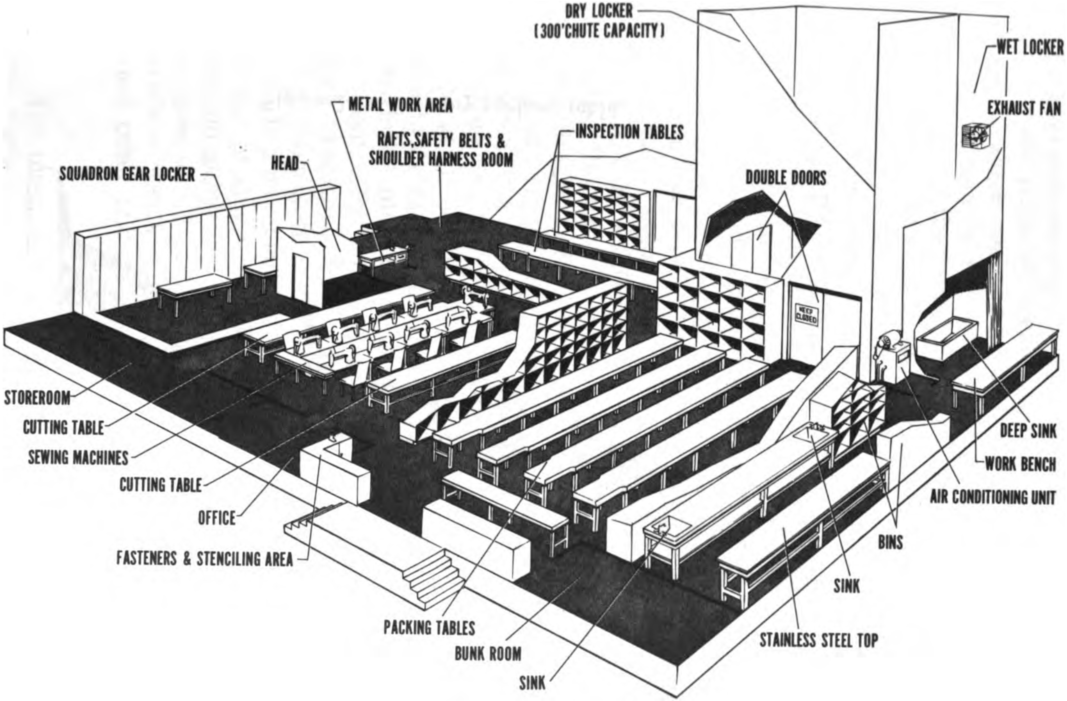


Figure 2-2.—Floor plan for a parachute loft ashore.

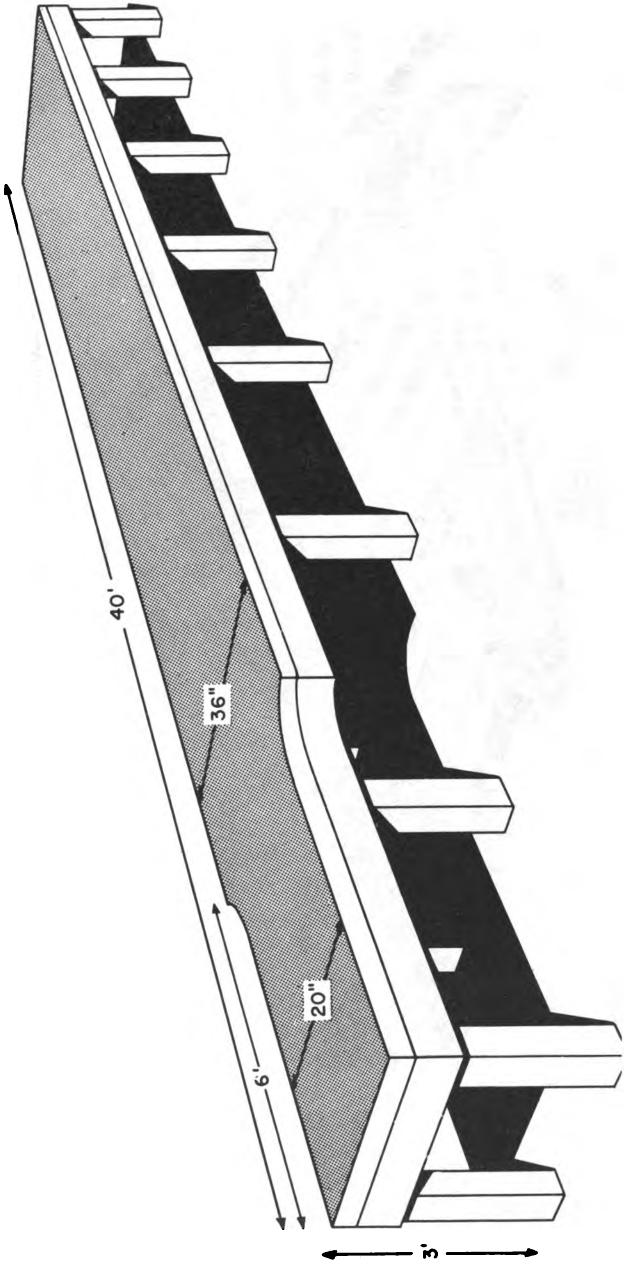


Figure 2-3.—Cutaway packing table.

be kept free of traffic. Spacing the tables at least 3 feet apart and parallel to each other provide the best arrangement. More room is needed at the foot of the tables than at the heads, where very little activity takes place.

Lighting the parachute loft is very important. It takes good eyes and good lighting to find stitching irregularities and ruptures in glossy white material. Fluorescent lighting has been found to be best, as it gives a flat light bright enough for packing, inspecting and sewing machine work.

MAINTENANCE.—The general maintenance of the packing section involves little more than keeping the spaces cleaned and waxed. Every effort should be made to keep all surfaces and edges of the packing tables smooth and free of splinters to prevent snagging the parachute canopy and lines.

AIR CONDITIONING.—For best results, if at all possible, the parachute loft packing spaces should be air conditioned. After the parachutes leave the dry locker they are rigged and packed for immediate use. The loft is usually a large unconfined area. Doors opening and closing constantly present air-conditioning problems. If it is at all possible, the temperature and humidity range should be that of the dry locker and not on a par with unpredictable outside conditions.

Controlled temperature and humidity prevents excessive dampness or dryness of the canopy material. Excessively dry cloth is more likely to generate static electricity. If a parachute is packed under conditions conducive to the production of static electricity, the electricity is packed along with the canopy. If this parachute should be jumped on a cold dry day, it may open rather slowly. The static electricity causes the folds of the canopy to cling to each other and may even be responsible for a streamer.

Dry Locker

The most important section of a parachute loft is the dry locker, or the drying tower, as it is sometimes called. This structure is used to condition the parachutes for packing. The height of the dry locker is determined by the length of the parachute from the peak to the ends of the leg straps on a QFS or NC6 parachute. A 28-foot parachute, suspended freely, requires a height of approximately 45 feet.

PARACHUTE SUSPENSION.—The methods used to suspend a parachute vary slightly, depending on the number of parachutes handled daily, available hardware, and the space available to properly space the hoisting lines for adequately drying and airing the parachute. Figure 2-4 illustrates 3 methods of suspending a parachute and the equipment involved. For adequate drying of parachutes, the hoisting lines should be a minimum of 2 feet apart.

The hoisting lines used to suspend parachutes must be free from harmful agents containing tars and oils. Braded cotton lines are the most flexible and best adapted for this purpose. Hardware used in constructing the suspensions, especially those coming in contact with the canopy, must be free from burrs and sharp edges.

LIGHTING.—Flush-type lighting fixtures are the safest to use in dry locker construction since the material of the parachute could easily be damaged if it touched an exposed hot lamp. If an insufficient number of these flush-type lighting fixtures are used, the resultant lighting will be very poor. Except for hanging and lowering the parachutes, there is little need for real bright lights. To supplement inadequate lighting from too few of the flush-type lighting fixtures, a fluorescent lamp that generates little heat may be installed on the surface of the wall or on the overhead. Some means of climbing up the inside of the dry locker should be provided to enable personnel to service the hoisting lines and lighting fixtures.

TEMPERATURE AND HUMIDITY CONTROL.—Every dry locker should be air conditioned with a unit capable of maintaining the recommended temperature and humidity range.

Humidity control is even more important than temperature, since dampness causes mildew in fabrics. The dehumidifying accomplished by the air-conditioning unit can reduce the moisture content of the air considerably. If the air-conditioning unit fails to decrease the humidity, a dehumidifier should be placed in the dry locker to supplement the air conditioner and bring the humidity down to the proper limits.

Difficulty may be experienced in keeping dry locker humidity within proper proportions during tropical rainy seasons in some areas, regardless of the extent of

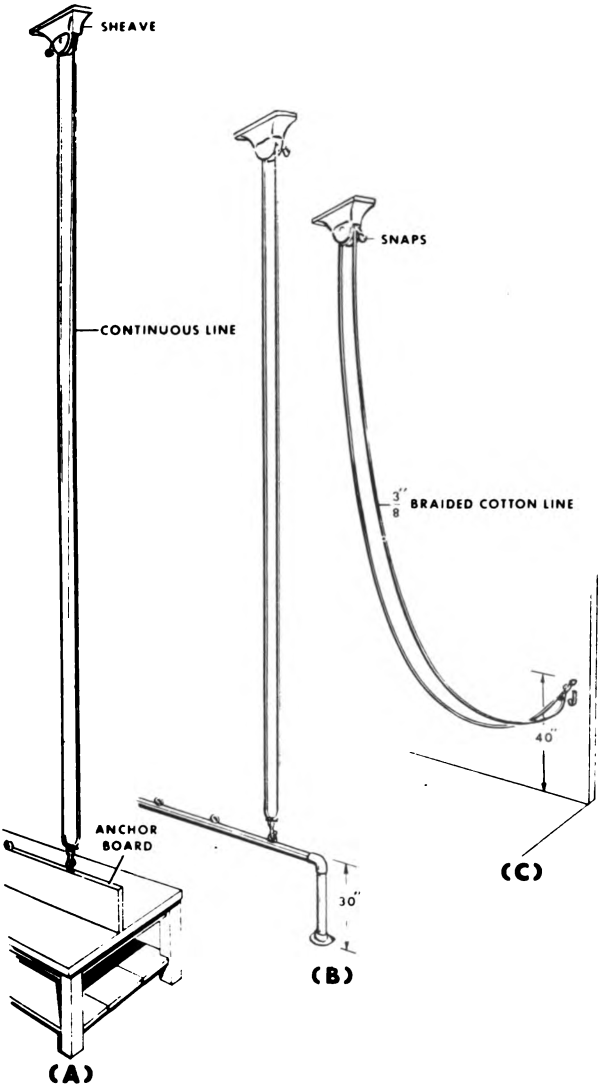


Figure 2-4.—Parachute suspension methods.

air-conditioning facilities. Under such conditions, magnesium chloride, a chemical which absorbs moisture in the air, will be very useful.

Set up a number of cheesecloth nets about 2 feet square and suspended at each corner approximately 2 feet from the deck. Place several handfuls of magnesium chloride in each net and provide drip pans under each net for catching the water. When the chemical has absorbed and shed a considerable quantity of water, it has a tendency to solidify. It must then be broken up so as not to impede its absorbing effects.

Table 2-1.—Parachute loft temperature and humidity ranges.

Location	Range	Temperature	Relative humidity
Dry Locker	Ideal	70° F.	40%
	Safe average	60° to 85° F.	30% to 60%
Storage	Ideal	70° F.	40%
	Safe average	60° to 75° F.	30% to 60%
Packing loft	Ideal	70° F.	60%
	Safe average	60° to 85° F.	30% to 60%

NOTE: The maximum temperature for any space is 110° F.

The temperature and humidity of the dry locker must be frequently checked if a reliable drying schedule is to be effected. There are various instruments applicable to recording temperature and humidity. Temperature and humidity ranges are shown in table 2-1.

SLING PSYCHROMETER.—A psychrometer is an instrument used for measuring the amount of water present in the atmosphere. The instrument consists of a wet-bulb and a dry-bulb thermometer.

As the water evaporates from the wick around the wet bulb, it is cooled, giving a lower reading than that of the dry bulb. The faster the water evaporates, the lower the reading on the wet-bulb thermometer. If no evaporation occurs, both thermometers will give the same reading, which means the air is saturated. Knowing both wet- and dry-bulb temperatures, the absolute and relative humidity may be easily determined from prepared charts accompanying the instrument.

The sling consists of a wooden grip with a swivel head and harness-type spring clip for attaching to the top hole of the psychrometer frame. For checking humidity, use a clear, open space, preferably exposed to the wind.

Rotate the instrument with the wrists for best results. The whirling should be approximately 120 r.p.m. Bring the instrument to a stop without any sharp jar, lifting it to eye level and read both thermometers to the nearest tenth of a degree, reading the wet bulb first. The whirling is repeated and other readings are made until the wet-bulb temperature fails to show further decline.

Calculate the difference between the dry-bulb and the wet-bulb temperature readings. After the difference is obtained, based on the barometric pressure nearest the normal atmospheric pressure, the next step is to enter the readings on the tables. The tables are found in the U. S. Weather Bureau Publication No. 235. The dry-bulb temperature is given in the vertical column at the left of the table, and the depression of the wet bulb printed across the top of the table. Dewpoint and relative humidity data are given as tabular values on correspondingly captioned pages.

For example, suppose the barometric reading is 30 inches of mercury, the dry-bulb temperature is 69° F., and the wet-bulb temperature is 61° F. As shown in table 2-2, the left-hand column is headed "Air Temperature," which is dry-bulb temperature and is in degrees Fahrenheit. The other columns are headed "Depression" at wet-bulb thermometer. This depression is the difference in the readings at the wet- and dry-bulb thermometers. In this example, the depression is 69 minus 61, or 8° F. Locate 69° F. in the left-hand column. Follow horizontally to the right on this line to the column headed 8.0. Now, read the value of the relative humidity, which in this case is 63 percent.

HYGROTHERMOGRAPH.—The humidity element of the hygrothermograph, the standard instrument for the measuring and recording of relative humidity and temperature, consists of separate strands of the best grade natural blond human hair, about 50 strands in all, spread into 8 groups. The hair element increases in length with rising or high humidities and decreases in length with falling or low humidities. These changes in length make it possible to make humidity markings on a record chart.

The relative humidity hair element is secured at the lower end to a pivoted end clamp. This is similar to that of the temperature element and permits adjustment of hair

Table 2-2.–Relative humidity, percent-Fahrenheit temperatures. Portion of U.S. Weather Bureau Publication No. 235.

Air Temperature	Depression of wet-bulb thermometer														
	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0
65	90	87	85	82	80	77	75	72	70	68	66	63	61	59	56
66	90	87	85	82	80	78	75	73	71	68	66	64	61	59	57
67	90	87	85	83	80	78	75	73	71	69	66	64	62	60	58
68	90	88	85	83	80	78	76	74	71	69	67	65	62	60	58
69	90	88	85	83	81	79	76	74	72	70	67	65	63	61	59
70	90	88	86	83	81	79	77	74	72	70	68	66	64	61	59
71	90	88	86	84	81	79	77	75	72	70	68	66	64	62	60
72	91	88	86	84	82	79	77	75	73	71	69	67	65	63	61
73	91	88	86	84	82	80	78	75	73	71	69	67	65	63	61
74	91	89	86	84	82	80	78	76	74	71	69	67	65	63	61

tension when setting to current humidity. The upper end of the element is attached to a small lever arm that operates the upper lever cam through a vertical link and lever arm. The marking pen, attached to this lever arm, is of the pressure gravity type.

The humidity and temperatures are read on a hygrothermograph chart by first finding the point at which the appropriate printed time curve intersects the humidity and temperature traces. This point is evaluated in terms of humidity and temperature by referrring it to the closest of the horizontal printed lines of numbers on the graph. The hygrothermograph should be mounted on a horizontal platform, centrally located in the dry locker, with the base at least 3 feet from the deck. (See fig. 2-5.)

The graph or chart should be filed for future reference and comparison. In this way the effectiveness of an air-conditioning system can be evaluated. In the absence of an air-conditioning unit, the records compiled by the hygrothermograph can justify the request for air conditioning. The chart is very simple to install on a rotating drum of the instrument, which is spring operated to run with the accuracy of a clock. The chart is marked from Monday through Sunday. Obviously, the time to change the graph is the first thing Monday morning. A key is provided to wind the eight-day mechanism.

Fabric Section

A well-established parachute loft has a range of sewing machines that will adequately handle light, medium, and heavy duty work. Light duty work, in most instances, is in the minority; while the medium work (heavily woven cloth and lightweight canvas) requires the greatest amount of time, and the equipment occupies the most space. Heavy canvas and webbings are in the middle of the workload program and the space and location allotted to these machines should be governed accordingly. Sewing machines are capable of performing perfectly, provided they are given the proper care and are used on the materials they were designed to handle. Maintenance and repair of sewing machines is covered in chapter 11.

CUTTING TABLE.—A cutting table should be from 30 to 33 inches high, so that the Parachute Rigger may

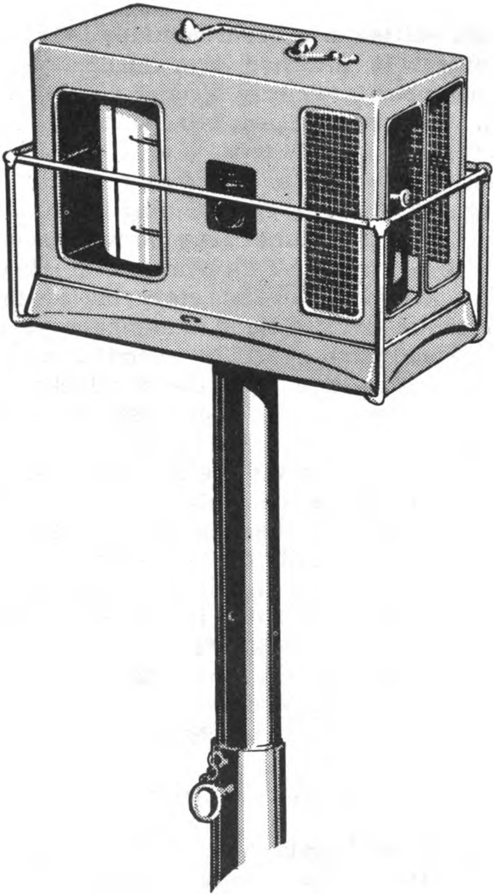


Figure 2-5.—Hygrothermograph.

comfortably perform any cutting operation. The table should be at least 54 inches wide to handle the most popular widths of materials. The length depends on the available area and the workload.

LOCKERS.—Lockers should be located in the vicinity of the fabric section. Small items like measuring instruments, and cutting, stapling, and setting tools should be safely stowed in lockers. Needles and spare sewing machine parts should be stowed in a manner to keep dust from them. The number and location of lockers required to satisfactorily stow all necessary items can only be determined by the available space in the parachute loft.

FABRIC RACKS.—A fabric rack of a simple and strong design, as shown in figure 2-6, is needed for the purpose of moving the material about the shop. This unit was constructed to withstand a load of 700 pounds. Not all fabric racks need to be portable. The major part of the work being performed, the location, and the facilities of the fabric section will determine the design of the rack.

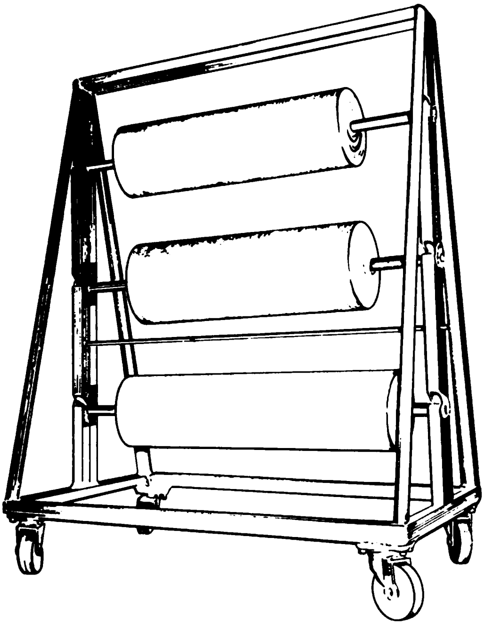


Figure 2-6.—Fabric rack.

STENCILING TABLE.—A table especially designed for stenciling purposes is a useful accessory. When a special table is not available, and when the lack of space restricts the number of tables, a combination worktable can be constructed. The construction should be heavy and sturdy with top dimensions large enough to accommodate a packed parachute when laid out flat. A drawer for stowing stencils and stenciling ink and brushes should be included.

A table of this type could be used for setting grommets, snaps, and fasteners. A small vise installed on the table has unlimited uses, and there should also be enough space for placing the wax pot, which is necessary in some fabric work. Another item installed on this table is a searing wire which can be locally constructed. It should be rigged across a gap and insulated. This searing wire will sever and sear the edges and ends of nylon in one operation.

Specifications, Characteristics, and Uses of Fabric Materials

The tensile strengths of the materials used in the manufacture and repair of parachutes are listed in Military Specifications. Specifications detail the physical quality of any product, depending on its use and purpose. All materials used in making a parachute are manufactured to the highest standards of workmanship. No one has the authority to change any item in the manufacturing process without the permission of the specifying agency. The parachute is therefore manufactured in strict accordance with many specifications and drawings, and must be so maintained throughout its service life if it is to perform properly.

A Parachute Rigger should not tolerate the use of substitutes or substandard materials in the fabrication or repair of survival equipment. A knowledge of specifications and tensile strengths better equips the Parachute Rigger to design local projects which must meet specified tensile strength requirements.

NYLON THREAD.—Nylon thread and cord are classified as types I and II, and are used in the manufacture of parachutes. Type I is a machine twist thread. Type II is a twisted bonded multicord thread. These threads and cords are in class 1, which is a low-stretch thread with a maximum elongation of 22 percent. Specifications for nylon thread may be found in MIL-T-7807.

The minimum breaking strength in pounds for nylon threads and cords follows:

Thread size:

A	2.75
B	5.50
E	8.50
FF	16.00

Cord Size:	
3	24.00
6	50.00

NYLON CORD.—Nylon cord used for suspension lines for pilot chutes and parachutes can be found in Specification MIL-C-5040A(ASG). Type I cord, 100 pounds breaking strength, is used for the lines of Martin-Baker pilot chutes. Type III, 550 pounds breaking strength, is used for constructing the suspension lines of the main parachute.

NYLON REINFORCING TAPE.—Reinforcing tape comes in many widths and styles. This tape is used on parachute container reinforcements, edgings, making hesitator loops and retainers, and general strengthening of all stress areas. Specifications for tapes used can be found in MIL-T-5038-2.

Many of the tapes can be identified by observing the patterns of their weaves. Type II tape is a plain weave. Type IV tape is composed of two ground warps. Type VI tape is a herringbone style which differs only slightly from type IV.

Type II tape is 3/4 inch wide and has a minimum breaking strength of 400 pounds. Type IV tape comes in both 1-inch and 1-1/2-inch widths. The 1-inch width has a minimum breaking strength of 1,000 pounds, while the breaking strength of the 1-1/2-inch is 1,500 pounds. Type VI tape is 3/4 inch wide and has a breaking strength of 425 pounds.

NYLON WEBBING.—Soft textile nylon webbing (Specification W-54) is used for constructing parachute harnesses. This webbing, 6,000 pounds breaking strength, is olive drab in color. The width is 1-23/32 ± 1/16 inches.

NYLON TUBULAR WEBBING.—Nylon tubular webbing is neutral in color and is used in reinforcement of the parachute canopy.

These webbings are covered in the following specifications:

MIL-W-4-88B (USAF).
MIL-W-6134.
MIL-W-5625.

The 1-inch nylon tubular webbing has a breaking strength of 3,000 pounds and is used for the vent reinforcement. The nylon warp and cotton filler webbing is also 1 inch and has a breaking strength of 525 pounds. It is used to reinforce the skirt hem. The 1/2-inch tubular webbing has a breaking strength of 1,000 pounds and is used for the Martin-Baker pilot chute connector cord.

NYLON PARACHUTE CLOTH.—Nylon parachute cloth is found in Specification MIL-C-7020B (ASG). This cloth is neutral in color unless otherwise specified, and is used in constructing the gores and panels of the parachute canopy.

The specification states that the maximum weight cannot be more than 1.1 ounces per square yard. The breaking strength in minimum pounds per inch of width is 40 pounds. The minimum tear resistance is 3.5 pounds for both the warp and filling thread. The air permeability in cubic feet per minute per square foot of cloth is 80 to 120.

HARNESS HARDWARE.—The harness hardware (Specification MIL-H-7195) comes in many styles and varieties. The uses of the hardware in the construction of the parachute harness can be found in this specification. Hardware that is salvaged from old or surveyed harnesses can be used for many different local constructions. The choice of hardware to be used depends on the use of the equipment and the test load to which the adapters, buckles, snaps, etc., will be subjected.

Laundry

Since the Navy is associated with salt water, it is only logical to expect an occasional salt water soaked parachute. Every parachute loft should be equipped with an inexpensive wash tub, located in a separate section remote from the dry locker, for the purpose of rinsing parachutes.

Hoisting lines rigged directly over the tubs offer an excellent means of pulling the parachutes out of the rinse water for drying. A fan located on the deck will move a greater quantity of air through the wet fabric than would otherwise be possible. Under no circumstances ever allow a wet parachute to be hung in the dry locker.

Storeroom

A separate storeroom is usually provided in larger parachute lofts, such as naval air stations and FASRons.

Heavy workloads will necessitate keeping a stock of various fabrics and materials on hand for ready use. It is not absolutely necessary to have a separate storeroom, as there is usually ample storage bins in the dry locker.

Parachutes that have not been put into commission should be left unopened in the container in which they are packed by the manufacturer. The method of pack is suitable for all climates. Dampness is no longer a problem since there are so many efficient dehumidifiers available.

Do not overstock on items that cannot be used in the normal time for routine requisitioning of materials from the Supply Department. Overstocking is a wasteful process, and storage space is inadequate in many spaces assigned to the parachute loft.

Flammable Gear Lockers

All flammable materials are to be stored in special lockers or shacks outside of the parachute loft. When in doubt about the flammable characteristics of liquids, cements, or pastes, check with the station fire department. Regardless of the location of the flammables, the structure housing them should be ventilated. Some flammables are rendered useless if frozen and must be stored at temperatures well above freezing. Before any of these items can be stored indoors in metal lockers away from heat sources, special permission must be secured from the squadron or station First Lieutenant. These officers are guided by local station regulations and the Fire Chief, who is responsible to the Commanding Officer for the fire security of all buildings and structures located on the base.

Avoid spontaneous combustion situations. Oil and paint-soaked rags should be placed in special containers provided for the purpose. When in doubt about the combustion potential of any liquid-soaked rag, hang it where the air can circulate freely around it. Never store dirty rags in a heap.

Safety Precautions

Since safety is a Parachute Rigger's job, every man assigned to the loft should be thoroughly checked out in safe working conditions. Each chapter in this training course gives standard safety precautions for the particular equipment with which it deals.

Common sense and supervision will eliminate many everyday accidents in the parachute loft. Sharp, clean tools, and the right tool for the right job should be used at all times. Substitutions can be dangerous.

Heavy voltage required for the sewing machines, air conditioner, wax pot, nylon cutters, etc., when all used at once, may overload the electrical circuits. When in doubt, always have a qualified electrician install and periodically check the electrical installations.

PARACHUTE LOFT ADMINISTRATION

As a senior Parachute Rigger in charge of the parachute loft, you will have a number of administrative duties and responsibilities. It will be your job to procure needed loft equipment and spare parts as well as flight clothing and other materials. You will plan, schedule, and direct work assignments; maintain an adequate file of aeronautical publications; interpret and comply with bulletins and other directives; maintain records and reports; carry on an instructional program for loft personnel; and instruct pilots and aircrewmen in the use of protective clothing and survival equipment.

Records and Reports

Records are important for proper accountability of materials and equipment as well as for logging inspections, modifications, and changes. Included among the records that must be kept are Parachute Record Cards, Parachute History Cards, life raft inspection, life jacket inspection, and the static load tests of aircraft safety belts and shoulder harnesses. Records should also be kept of oxygen regulator bench checks, regulator modification changes, and oxygen cylinder contamination tests. These records are subject to inspection at any time by higher authorities and should be kept neat, accurate, and up to date at all times.

Since the actual keeping of the above records is usually performed by a lower rated man, proper procedures for maintaining them have been included in *Parachute Rigger*

3 & 2, NavPers 10358, Volume 1, and are therefore not repeated here.

In addition to the above records, there are a number of reports that must be submitted by the Parachute Rigger from time to time. Included among these are material failure reports, maintenance usage reports, and survey requests. Procedures for submitting these reports are described on the following pages.

MATERIAL FAILURE REPORTS (FUR's).—All naval activities operating and maintaining aeronautical equipment are required to prepare and submit reports concerning failures or unsatisfactory conditions relating to all aeronautical materials used in connection with the operation, maintenance, overhaul, and manufacture of aircraft and associated equipment. Data provided by these reports are required for use in the Navy Reliability Program.

The purposes of these reports are (1) to supply accurate and current information concerning the kinds and numbers of specific failures, (2) to provide facts useful as guides in procurement of equipments and supplies, and (3) to give data pertaining to the reliability of existing equipment and indicating any need for modification or redesign.

The system of reporting employs the Failure, Unsatisfactory, or Removal Report, Form NavAer 3069, commonly referred to as the FUR. These forms are supplied as eight-page sets with carbon interleaves, and all eight sheets are used for the majority of reporting situations. The first sheet of the set is available in pads of 100 for use as worksheets and also for reporting unsatisfactory conditions where a turn-in of material is not required.

The FUR forms are supplied by regular publication supply sources and may be ordered on Publications and Forms Order Blank NavAer 140.

A FUR form is made out whenever a part or item of equipment has exhibited a malfunction, has failed, or is removed from an assembly or system. High usage items such as bolts, nuts, and the like do not require a FUR report except in cases where an item requires abnormal replacements or fails far short of expected life.

A separate FUR is required for each item replaced, except when a quantity of like items with the same stock number identification are replaced. In the latter case a single FUR may be used.

The top sheet of the eight-page set is the basic reporting document and is sent to the FUR Center. Pertinent data is entered on the other sheets by carbon registration.

Operating activities are responsible for insuring that the reports submitted contain an accurate description of the failed item, including the correct stock number, part number, manufacturer, and contract number. Efforts should be made to determine precise causes of component failures or malfunctions.

The FUR is commenced by the individual performing the maintenance operation or discovering the unsatisfactory condition. In accordance with the convenience of each organization, the FUR set may be completed by persons possessing records helpful in providing operating time, parts identification, and other necessary data. If the failure is investigated, the person or persons making the investigation will complete the FUR. Signature should be by the senior person involved in the preparation or review of the FUR. Petty officer signatures are particularly encouraged for FUR's not requiring investigation.

Complete instructions, including completed samples of the different types of FUR's, are found in *BuAer Instruction* NavAer 00.58B. This instruction should be read and used by all personnel concerned with submitting FUR's.

MAINTENANCE USAGE DATA.—The Aviation Supply Office (ASO) has established a procedure to be used by specifically designated maintenance activities in reporting material usage. The purpose of reporting this data is to provide a basis for computing amounts of maintenance material that must be purchased and made available for maintenance. It also provides data that is used in determining quantities of items allowed by the allowance lists for each organization.

The maintenance usage data report lists the quantity of parts, subassemblies, or assemblies actually removed during a reporting period because of unsatisfactory operation, and for which a replacement was required. When subassemblies or assemblies are repaired locally, usage reports should not indicate usage of the subassembly or assembly, but should indicate only the parts utilized in effecting the repair. Reports of assemblies or subassemblies used should cover only those sent to O and R.

The Maintenance Officer is responsible for collecting and submitting the maintenance usage report to ASO. Each shop, including the parachute loft, is required to keep a daily usage record and turn it in to the maintenance office monthly. The data are then compiled and entered on the form supplied by ASO. This report is to be submitted to ASO by the 5th day of the following month.

SURVEY REQUESTS.—A survey is the procedure required when an accountable item must be expended from the records due to loss, damage, deterioration, or normal wear. The survey request provides a record showing the cause, condition, responsibility, recommendation for disposition, and authority to expend the material from the records. Since parachute lofts stock and maintain a great deal of accountable material, it is necessary for Parachute Riggers to have a knowledge of survey procedures.

The custodian of the item to be surveyed prepares a written statement of the circumstances as known or suspected. The Survival Officer then originates a rough Survey Request, Report, and Expenditure (SandA Form 154). It is processed through the Operations Officer and then to the Supply Officer for preparation of the smooth survey which is then signed by the Survival Officer, Operations Officer, and Commanding Officer.

There are two types of surveys—formal and informal. A formal survey is required for those classes of material so designated by the bureau or office concerned, or the Commanding Officer. The survey is conducted by a commissioned officer or a board of three officers, as appointed by the Commanding Officer. Informal surveys are conducted by the department head when directed by the Commanding Officer.

When a person in the naval service is found to be culpably responsible for actions necessitating a survey, he will be contacted by the surveying officer for a statement. The surveying officer must then recommend disciplinary action as the circumstances require. A note of such action will be made on the survey report and the Chief of the Bureau of Naval Personnel notified of the disciplinary action taken.

Procurement of Materials and Equipment

Procurement of materials and equipment is one of the most important responsibilities of senior Parachute Riggers. The parachute loft must not only be equipped to perform the required workload, but also must carry many items for reissue to flight personnel. The best guides are BuAer *Allowance Lists and Tables of Basic Allowances*.

ALLOWANCE LISTS.—*Allowance Lists and Tables of Basic Allowances* are identified by sections. They contain listings of equipment and materials (both expendable and accountable) authorized for use by the various types of activities. Certain sections such as A, H, and U are issued as individual publications. Others such as B, BR, and R are issued as a series of publications, each of which is applicable to a specific model of equipment, model of aircraft, or type of activity. Sections of primary interest to the Parachute Rigger are Sections A, B, H, and K.

Section A is a listing of standard aeronautical and Navy stock account material, and includes such items as webbing, fabric materials, needles, and oxygen equipment. Section A does not indicate what the parachute loft is authorized as an outfitting allowance, but is handy as a reference for stock numbers and nomenclature.

Section B is issued for each model of naval aircraft. This list contains valuable information for ordering parts for a specific aircraft, such as oxygen regulators.

Section H contains listings of flight operational materials which squadrons and other activities rate as a commissioning allowance. Such items as parachutes, life jackets, dye markers, shark chasers, and other miscellaneous items are contained in this section.

Section K lists the general types of aeronautical publications and forms which are provided as a commissioning allowance for all types of activities.

REQUISITIONING MATERIALS.—Defense Department Forms DD 1150 and 1150A, *Request for Issue or Turn-in*, are used by aviation activities both ashore and afloat to requisition or turn in materials. Form DD 1150 (white) is used to requisition materials and is prepared in multiple copies. Local requirements determine the number of copies to be prepared. Each class of material must be requisitioned on separate sets of forms. Form DD 1150A (yellow) is used to turn in materials. It must also be prepared in multiple copies with each set utilized for only one class of material.

In addition to the above standard forms, there are numerous local type forms in use. These local forms are issued by local supply activities to simplify the process of requisitioning material. However, when local forms are used, the supply activity must complete standard forms on the items issued.

OPEN PURCHASE.—In the procurement of materials, items not stocked by the Navy Supply Department are sometimes needed. Procurement of such items is known as open purchase. An example of materials which the Parachute Rigger must procure by open purchase is spare parts for sewing machines, needles excepted. From time to time, it may be necessary to procure other needed items by this method.

Station Supply Officers are authorized to effect local purchase of aeronautical material in classes 5 through 94 without prior approval of the Aviation Supply Office, provided the cost does not exceed $500.00 and certain other conditions are met.

When an activity desires to make a local purchase of aeronautical material in excess of $500.00, the activity must submit a request to the Aviation Supply Office giving the following information:

Priority indicator.
Date material required (DMR).
Justification.
Request number.
Quantity required for immediate use.
Name and address of local supplier.
Statement as to whether station funds are or are not available.

After receipt of the request containing the required information, the Aviation Supply Office determines the type of procurement to be used. The activity concerned may be authorized to procure as requested. However, in some cases, especially when applicable local allotments are not available, the Aviation Supply Office may initiate procurement with the local supplier and request the activity concerned to pick up the material.

Flight Clothing Pools

Flight clothing pools are maintained for the purpose of providing flight clothing to individuals not eligible to receive such items on a personal-issue basis.

The Supply Officer of an aviation supply activity or the Supply or Material Officer of the fleet aviation unit arranges for the establishment of flight clothing and parachute pools sufficient to meet necessary operational requirements. The Commanding Officer will designate an officer, other than an officer connected with Supply Department, as the responsible officer of the pool.

Issues of flight clothing, flight operational equipment, and parachutes to the pool by the Supply Officer will be made on *Request for Issue or Turn-in* (DD Form 1150). Items of flight clothing other than Navy stock account material so transferred will be expended as a cost charge to the current appropriation expenditure, account 33020, and appropriate allotment of the aviation squadron or station concerned.

Initial outfitting of the flight clothing and parachute pool will be considered as nonreplenishable issues; subsequent issues to replace torn, lost, or overage items will be considered as replenishable issues. Flight clothing and parachute pools operated by squadrons will carry only those items and quantities authorized by Bureau of Aeronautics Allowance Lists. Equipage stock card and custody record will not be maintained by the issuing Supply Officer for items issued to fill the authorized Section H Allowance Lists. The squadron Commanding Officer or his designated representative will be responsible for the accountability of equipage items carried in the flight clothing and parachute pools.

Normally, used articles of flight clothing and equipment will be issued to these pools; new items will be issued only when used material is not available. For hygienic reasons, shoes (field, N-1) and summer caps will not be included in the pool.

When an individual not otherwise eligible requires flight clothing and equipment for flight purposes, such items as are needed will be furnished to him from the pool, and a custody receipt will be signed by him for the items furnished. On completion of the orders to duty involving flying or the flights for which the clothing was needed, the individual will return the items to the pool, at which time the custody receipt will be surrendered.

If an individual being transferred from one station to another requires flight clothing en route, the necessary clothing will be issued from the flight clothing pool and will be covered by a custody receipt signed by the individual. Such clothing will be invoiced by the issuing activity to the activity to which the individual is being transferred. Original signed custody receipts will be attached to the original invoice.

Pilots and aircrewmen will be issued flight clothing from the pool. A custody receipt will be signed by the individual for the items furnished. Upon completion of the orders to duty involving flying, or when he is transferred to another station, the individual will return the items to the pool at which time the custody receipt will be surrendered.

Articles of flight clothing will be returned to the pool when:

1. They have become unserviceable because of damage or wear.
2. They are in need of cleaning or repair.
3. A different size is required for proper fitting.

PREPARATION FOR DEPLOYMENT.—In preparing for deployment to an advanced base or forward area, the senior Parachute Rigger in charge of the loft is responsible for estimating material and equipment requirements. Obviously, the geographical location of the base or area will be a determining factor in any such preparation. For example, it would be a waste of time and material to take heavy woolens to the tropics or lightweight protective clothing to the arctic.

The best policy is to make a thorough check of all applicable allowance lists and make certain all authorized materials are on hand. In addition, make certain all parachutes, life jackets, rafts, etc. are in the best of condition and that the final "striking date" will not occur while deployed. Always keep in mind that Supply at most advanced bases does not stock many of the items which might be required for immediate use. Do not wait until the last minute to order supplies and equipment needed. Advance planning is especially important for procuring spare sewing machine parts and other items that have to be obtained through open purchase.

Special equipment and protective clothing which will be required by the activity and is not authorized in the applicable allowance lists will be determined and authorized by the Parachute Officer through Supply.

Aeronautical Publications

Aeronautical publications are issued by authority of the Chief of the Bureau of Aeronautics and are the sources of information for guiding naval personnel in the operation and maintenance of all aeronautical equipment within the Naval Establishment. Each parachute loft is required to maintain an up-to-date file of publications relating to the equipment under its jurisdiction.

Aeronautical publications may be grouped into two major classes or groups—those issued in the form of Manuals and those issued in the form of Letter Material.

When a new item of equipment is accepted by the Navy, manuals necessary to insure its proper operation and upkeep are prepared and issued to all activities using and/or maintaining the equipment. Supplemental information and other directive-type publications that must be issued from time to time are issued in the form of letter material.

As an example, when a new oxygen regulator is accepted by the Navy, a manual covering maintenance of the regulator is issued. Later, if it becomes necessary to issue information concerning repair or use of the regulator, or a modification to the regulator is necessary, letter-type publications are issued.

All publications, both manuals and letter material, are assigned a title and code number and listed in the *Naval Aeronautic Publications Index* when available for issue. In order to use aeronautical publications intelligently, a general knowledge of the index numbering system is necessary.

NUMBERING SYSTEM FOR MANUALS.—Code numbers assigned to manuals consist of a prefix and a series of three parts. The prefix may consist of NavAer, AN, TO, or CO.

NavAer, usually shortened to NA, indicates that the publication was originated by the Bureau of Aeronautics.

The prefix AN was previously assigned for manuals used by the Bureau of Aeronautics and the Air Force when they were prepared to coordinated Military Specifications. This prefix, while no longer assigned for new material, will remain in effect for existing assignments or until superseded by a later assignment.

TO is the prefix assigned to an Air Force originated manual.

CO was previously used to designate a manual with a confidential security classification. This prefix, while no longer assigned for new material, will remain in effect for existing assignments or until superseded by a later assignment.

The three parts which make up the remaining portions of the number indicate the following:

Part I is a two-digit number that indicates the general subject classification of the equipment covered by the publication. Table 2-3 lists the general subject categories and their numerical equivalents.

Part II of the publications number consists of numbers and/or numbers and letters and indicates the specific class, group, type, or model of the equipment. The subject breakdowns are listed at the beginning of each separate major division within the index.

Part III consists of a number or numbers which designate a specific manual. For aircraft and power plants, this number designates a specific type of manual. For other types of equipment this part is assigned in numerical sequence and has no reference to the type manual.

An example of a complete code number and its breakdown is the *Overhaul Instructions Handbook* for the Automatic Positive Pressure Diluter Demand Oxygen Regulators, publications number AN-03-50A-48:

AN indicates that the manual was prepared to coordinated Military Specifications for joint use by the Navy and Air Force.

03 indicates that the publication is an accessories manual (table 2-3).

-50 indicates that the manual concerns oxygen equipment. The letter A has no specific significance in this case, but merely distinguishes this manual from another 03-50 series manual.

-48 is the numerical sequence number, indicating that this manual is the forty-eight publication issued in the AN-03-50A series.

As shown in table 2-3, manuals of primary concern to the Parachute Rigger are issued in the 03 series (accessories), 13 series (Parachutes and Personal Equipment), and the 17 and 18 series (Machinery Tools and Test Equipment). Others with which you might be concerned from time to time are issued in the 00 series (General) and 01 series (Aircraft). Included among the 00 series are *Allowance Lists* (00-35), *Air Safety* (00-75), and *Aviation Training* (00-80). All 01 series manuals concern specific models of aircraft.

Table 2-3.—General subject classification numbers for manual-type publications.

General	00
Aircraft	01
Power plants	02
Accessories	03
Hardware and Rubber	04
Instruments	05
Fuels and Lubricants	06
Dopes and Paints	07
Airfield Lighting Equipment	08 and 20
Photography	10
Armament	11
Fuel and Oil Handling	12
Parachute and Personal Equipment	13
Hangars and Buildings	14
Standard Preservation and Packaging Instructions	15
Electronics	08 and 16
Machinery, Tools, and Test Equipment	17 and 18
Ground Servicing and Automotive Equipment	19
Chemical Equipment	24
Instructional Equipment and Training Aids	09 and 28
Training and Informational Literature	30
Aerology	50
Ships Installations	51

NUMBERING SYSTEM FOR LETTER MATERIAL.—Letter material is numbered by three different methods. They are as follows:

1. Numbered in consecutive order on a calendar year basis. This method is used in the numbering of *Aviation*

Clothing and Survival Equipment Bulletins, Accessories Bulletins, Technical Orders, and *Technical Notes.* For example, *Aviation Clothing and Survival Equipment Bulletin* 18-58 is the eighteenth bulletin of this type issued in the year 1958, and *Accessories Bulletin* 31-57 is the thirty-first *Accessories Bulletin* issued in the year 1957.

2. Numbered in consecutive order according to subject matter. This method covers all *Instructions and Notices.* An example is *BuAer Instruction* 4750.1. The number 4750 indicates the general subject of the instruction, and the .1 indicates that it is the first instruction issued by the Bureau of Aeronautics on that particular subject.

3. Numbered in consecutive order according to specific application. An example of this method is the numbering of *Aircraft Service Changes* and *Aircraft Bulletins.* As a Parachute Rigger, you will seldom be concerned with directives in this category.

AVIATION CLOTHING AND SURVIVAL EQUIPMENT BULLETINS.—Without a doubt, the most important letter-type publication, as far as the parachute loft is concerned, is the *Aviation Clothing and Survival Equipment Bulletin.* These bulletins may contain instructions for modifying, repairing, testing, or using an item of clothing or survival equipment. A complete file of all those in effect must be maintained in the loft at all times.

Each bulletin contains complete instructions for performing the work and includes a list of materials required, source of the materials, disposition of removed materials (if applicable), and the estimated number of man-hours required. A blueprint, or working drawing, is also included and used as a guide in performing the work.

INTERPRETING AND COMPLYING WITH BULLETINS.—Interpreting of bulletins and supervising the job of complying with them requires careful reading and study on the part of the senior Parachute Rigger. In many instances a knowledge of blueprint reading is also necessary.

If you have not had previous training in bluepring reading, it is suggested that you obtain a copy of *Blueprint Reading and Sketching* (NavPers 10077-A) from your education officer and study chapters 2 and 3.

If you have had some experience with blueprint reading, but need to refresh your memory on the meaning of certain lines and symbols, study figures 2-7 and 2-8. Figure 2-7 illustrates the various draftsman's lines; figure 2-8 is taken from *Aviation Clothing and Survival Equipment Bulletin* 42-57 and illustrates some of their uses. Further descriptions and uses are given in the following paragraphs.

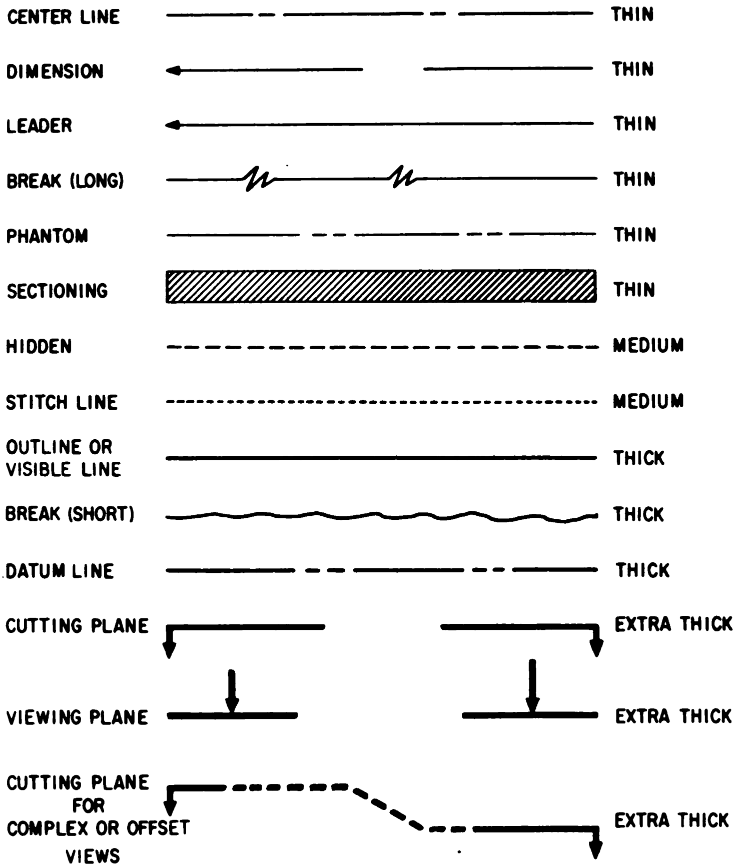


Figure 2-7.—Draftsman's lines used on blueprints.

Center lines are made up of alternate long and short dashes and are used to indicate the center of a circular object or part of an object.

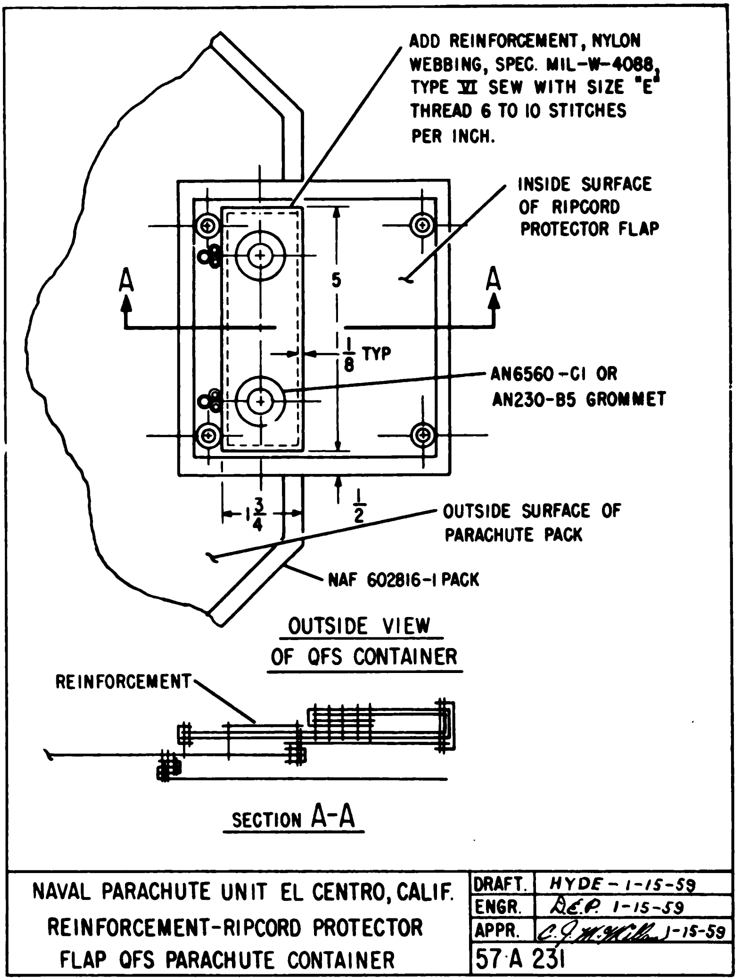

ADD REINFORCEMENT, NYLON WEBBING, SPEC. MIL-W-4088, TYPE VI SEW WITH SIZE "E" THREAD 6 TO 10 STITCHES PER INCH.
INSIDE SURFACE OF RIPCORD PROTECTOR FLAP
A
A
5
$\frac{1}{8}$ TYP
AN6560-C1 OR AN230-B5 GROMMET
$1\frac{3}{4}$
$\frac{1}{2}$
OUTSIDE SURFACE OF PARACHUTE PACK
NAF 602816-1 PACK
OUTSIDE VIEW OF QFS CONTAINER
REINFORCEMENT
SECTION A-A
NAVAL PARACHUTE UNIT EL CENTRO, CALIF.
REINFORCEMENT-RIPCORD PROTECTOR
FLAP QFS PARACHUTE CONTAINER
DRAFT. HYDE - 1-15-59
ENGR. R.E.P. 1-15-59
APPR. 1-15-59
57 A 231

Figure 2-8.—Example of blueprint accompanying a bulletin.

Dimension lines are solid lines with arrowheads at either end and indicate dimensions or distance between two points on the drawing.

Leaders are solid lines with one arrowhead and are used to indicate a part or portion to which a note, number, or other reference applies.

Break lines are indicated by solid, freehand lines, and indicate that a portion of the object is not shown on the drawing.

Hidden lines consist of short dashes evenly spaced. Hidden lines are used to show the hidden features of a part.

Stitch lines indicate sewing or stitching lines and consist of a series of dots or very short dashes evenly spaced.

Cutting plane lines are used to indicate the plane in which a cross-sectional view of the object (shown elsewhere on the drawing) is taken. For example, in figure 2-8 the cutting plane line indicates the plane in which section A-A is taken.

Section lines are used to indicate the exposed surfaces of an object in a sectional view. Section lines are often referred to as cross hatch lines.

PROCUREMENT OF AERONAUTICAL PUBLICATIONS.—Requests for publications for which the publication code number and/or title is known should be addressed to the nearest publications supply point. The addresses of these supply points and the geographic areas served by each are listed on the inside front cover of the *Naval Aeronautic Publications Index*. Form NavAer 140 should be used.

Changes to automatic distribution and inquiries concerning publications not listed in the Index should be addressed to the Officer in Charge, Naval Air Publications Facility, Philadelphia, Pennsylvania. NavAer Form 2126 should be used in all cases concerning changes to automatic distribution.

Section K of the BuAer *Allowance List* outlines the general types and classes of aeronautical technical and training publications and forms which are provided as a commissioning allowance for all types of activities.

Training of Loft Personnel

Training of loft personnel is a necessary function of the parachute loft and one of the most important responsibilities of senior Parachute Riggers. The extent to which you fulfill this responsibility will determine your ability as a supervisor and a petty officer. Much of what you know about your work came to you from the instruction of more experienced men.

Two methods of carrying on a training program may be used. One is by scheduled lectures, supplemented by assigned reading. The other is by the more informal on-the-job training. The experienced men in the loft should be utilized as fully as possible in instructing, demonstrating, and imparting their skills to the less experienced. Practically every task performed in the loft presents an opportunity for on-the-job training. The only equipment required is the job itself. The striker or trainee will learn something by seeing the job done, and he will gain experience by having a chance to participate in its accomplishment.

Whether or not loft personnel are able to take care of peak workloads will depend a great deal on how well you have utilized lax periods for training inexperienced personnel.

INSTRUCTING PILOTS AND AIRCREWMEN

Another important responsibility of the Parachute Rigger is to insure that flight personnel and passengers have equipment available which is reliable for personal safety in flight or for escape and survival in emergency, and to insure that these people are instructed and trained under simulated conditions in the use of this equipment and in the techniques of personal safety and survival.

From aircraft accident statistics it has become unmistakably clear that modern high performance aircraft are mercilessly unforgiving of the mistakes of the pilot or aircrewman, of inadequate facilities, of faulty design or material, of poor maintenance, or of deficiences in supervision which result in inadequate safety of the flying operation.

The Safety and Survival Factors Division analyzes and evaluates aviation safety and survival equipment and its utilization, as revealed by aircraft accident and incident information, in order to appraise the adequacy of existing and projected design, techniques, and procedures.

Human failure is the most frequent single cause factor of aircraft accidents. The primary objective of the safety program is the prevention of aircraft accidents resulting from human failure.

A further objective is the promotion of the personal safety of pilot, aircrew, and passengers in flight and the provision for escape and survival of these personnel following aircraft emergencies. Recent studies have established that biological and psychological factors not only are the single cause factors of a large number of aircraft accidents, but that they invariably are interrelated with other cause factors.

The term SAFETY AND SURVIVAL EQUIPMENT covers all items of equipment designed to provide the basic human physiological requirements under flight conditions (for instance, oxygen systems, anti-g suits, pressure suits, droppable boats, kits, and the like). The term also covers all equipment designed to prevent injury to pilot, aircrew, or passenger in flight or in emergency evacuation of the aircraft and all equipment designed to promote survival of downed personnel pending rescue.

Recently, major effort of the safety and survival equipment program has been directed to the area of personal escape devices, equipment, and procedures. Anticipated accomplishments in this area appear to offer immediate and substantial contributions to the safety program. Efforts to increase the reliability of ejection seats have resulted in an increased percentage of successful ejections. Approximately 70 percent of attempted emergency ejections from Navy aircraft were successful in 1952-1953, approximately 80 percent in 1954-1955, and approximately 90 percent in 1956-1957.

Procedures for premeditated parachute jumps and for bailing out of troop carriers are well planned. The question of how to get out of a crippled fighter or attack plane is a subject of many discussions. The pilot must employ the training he received in flight school and individual judgment for ejecting or bailing out of the various Navy aircraft he might be called on to fly.

In emergency escape procedures, no two situations are alike in every detail. The most important factor for a man making preparations for bailing out is to keep his wits and remember his training. The training the pilot and crewmen have received must then be applied as the conditions of the emergency exists.

Emergency escape and ditching procedures have been formulated for every type of naval aircraft to familiarize pilot and aircrewmen with the best escape methods and escape paths to follow. These procedures clearly show the location of each working station in relation to the location of the parachute for each man, and the assigned path of exit. Information relative to the emergency escape procedures can be found in the *Flight Handbook* for any given type of aircraft. The senior Parachute Rigger should take steps to study the escape procedures for his particular squadron or unit, so that he can be better informed for instructing the pilots and aircrewmen on the subject. It will also be necessary to instruct personnel assigned to the parachute loft on the use, care, and maintenance of the equipment.

Parachute Landings

All personnel who fly, frequently or occasionally, should be instructed in parachute landings other than routine landings under ideal conditions. Routing landings, which are covered in *Parachute Rigger 3 & 2,* NavPers 10358, Volume 1, should not be disregarded, as the information given there is the basic procedure for almost all parachute landings.

HIGH WIND LANDINGS.—Landing safely with a parachute in high wind is not an easy task. Initial touch down may seriously injure the jumper or make him unconscious, which would make it impossible for him to defend himself. However, proper technique is extremely helpful in reducing the chances of death or injury during high wind landings. The danger lies in the fact that a high wind is capable of keeping the canopy inflated and dragging the jumper across the ground, thus causing serious injury or possibly death. The jumper is responsible for deflating the canopy after landing, so he should be thoroughly indoctrinated in the method of deflating the canopy.

A jumper may elect to unsnap his harness during the descent and allow the harness to pull from his body after touch down. The unsnapping may ONLY BE DONE IF THE JUMPER CAN MOVE BACK AND SIT IN THE SLING OF THE HARNESS, with no weight on the leg straps. To slide back into the harness sling, grasp the main sling on each side near the seat, apply pressure towards the knees and kick your knees sharply toward your chest. Disconnect the snaps attaching both leg straps FIRST and then the chest snap, but do not remove your arms from the body straps. Grasp the lift webs with each hand and extend your arms over your head and then release the harness at the instant your feet touch the ground. In many cases it is impossible to use this technique due to body configuration, bulky clothes, etc.

A new canopy release has been developed that enables the pilot to disconnect the canopy from his harness as soon as he lands. This new release makes it possible for the aviator to free himself of the canopy without his being dragged over the ground or through the water by the wind. The set of pictures in figure 2-9 shows the details of construction. This release is used only with the integrated torso harness in the A4D, F8U, TT1, A3J and T2J aircraft. Instructions should be emphasized to never tamper with the safety lock on these ejection snaps during descent. Accidentally releasing the ejection snaps during descent will release the canopy from the harness and the body will be dropped into a free fall.

If the parachute is not equipped with ejection snaps and the jumper cannot safely release the leg snaps, he should elect to land with the harness fully snapped. Since unsnapping a harness while being dragged across the ground is next to impossible, collapsing the canopy by deflating can be accomplished regardless of wind velocity if the jumper remains calm and applies the deflating technique with determination. Deflation on land is accomplished by pulling in on any bottom suspension line or group of suspension lines.

The deflating process can burn the hands and fingers. The lines should be grasped with a sideward twisting motion of the hands and wrists as each new snubbing grip is made along the lines. After the canopy has been deflated, it is a good practice to sit on the canopy while unsnapping and preparing to slide out of the harness.

Excellent practice can be accomplished deflating a canopy on a windy day. Using a surveyed parachute on an open field, a couple of men can whip the canopy until it is inflated. This will drag the wearer across the ground, and after a few tries, he will be able to deflate the canopy with proficiency. For safety purposes, a few men should be present close to the inflated canopy. In the event the

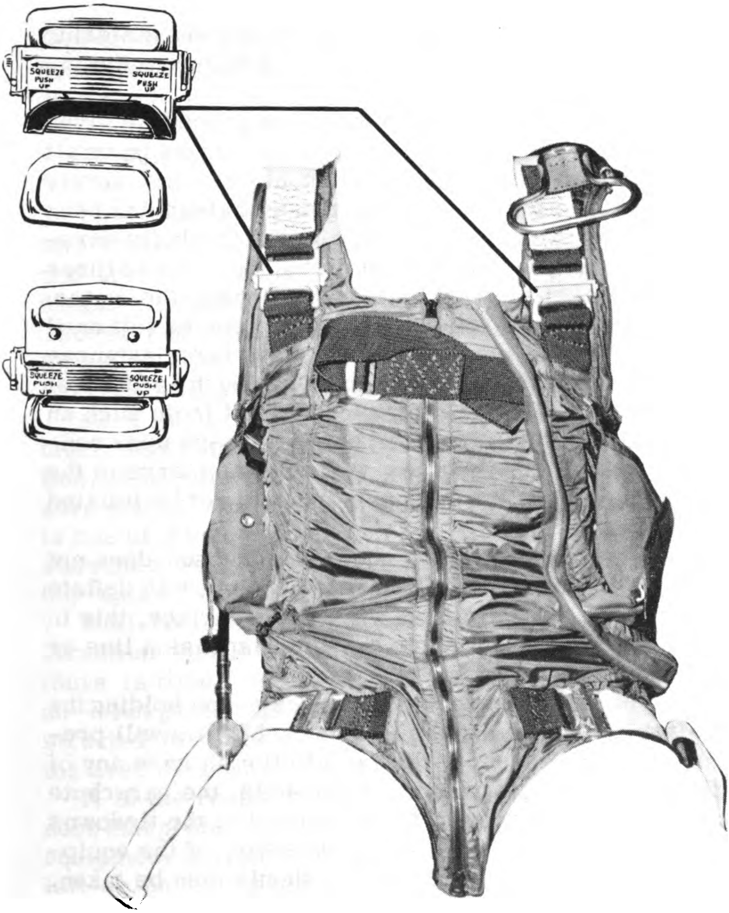


Figure 2-9.—Quick-acting canopy release.

wearer is unable to deflate the canopy on his first try, the canopy can be deflated by a man catching the peak of the canopy and running around into the wind. On some stations, a wind machine is provided for the purpose of deflating canopies under simulated high wind conditions.

WATER LANDINGS.—Under some conditions the most desirable place to land with a parachute is in the water. The primary object is to get free from the parachute harness at the instant one touches the water. Entering the water wearing the harness greatly hampers the individual's movements.

Landing in water calls for the same procedure given for a high wind landing. While still airborne, the pararaft should be removed from the kit container and slowly lowered until the full length of the retainer strap has been released. Depth perception over water is wholly unreliable for accurate judgment of distances. The harness should not be unsnapped until approaching the water. Under no circumstances should the harness be left until contact is made with the water. There have been instances where jumpers have left the harness as much as 200 feet above the water. Severe injury may result from such an extended fall. After sliding out of the harness upon contact with the water, the body will only submerge to the shoulders or head. The life jacket should not be inflated until in the water.

In the event the wearer for some reason does not slide clear of the harness and it is necessary to deflate the canopy due to high winds on the water surface, this is accomplished by pulling in on any top suspension line or group of suspension lines.

Before inflating the pararaft, all the snaps holding the pararaft in the case should be released. This will prevent tearing the raft body during inflation in case any of the flap securing snaps jam. If possible, the parachute should be saved and everything secured to the tiedowns on the pararaft for future use. An inventory of the equipment provided in the pararaft kit should then be taken. The individual should be thoroughly familiar with the use of the equipment before it is needed, because most of the time a person only has a few seconds to put this equipment into operation.

TREE LANDINGS.—Landing in trees is not necessarily always hazardous. The feet should be kept pressed tightly together and the face protected by crossing the arms and laying the face down into the arms. The top branches of a tree will snap off under the impact. No attempt should be made to grab any branch and hang on until the canopy has caught on a branch and the body has stopped falling.

The amount of swing and various other dexterous activities that may be performed in descending from the tree depends on two things: First, how firmly the parachute is entangled with the branches of the tree; and second, the distance to the ground.

Survival and Air-Sea Rescue Equipment

The sea has ever been the implacable enemy of those who venture into or over its wastes, and modern rescue and survival equipment is designed to give victims of a disaster every possible chance to escape its clutches. The Navy has seen to it that the newest products of human ingenuity have been perfected and made available to the Parachute Rigger for the saving of lives.

As a senior Parachute Rigger, you have a threefold task. You must maintain the equipment in perfect condition, be proficient in the use of such equipment, and be sure that all who use it are equally proficient. The latter is one of the new requirements for advancement to Chief Parachute Rigger, effective as of the date of Change 12 to the "Quals" Manual.

Well-considered preparation, familiarization, and instruction in the use of survival equipment, made while there is time to prepare, will help flight personnel when an emergency exists. Every individual should be instructed to dress to cope with the physical conditions of the area over which he must fly and fight.

It is the responsibility of the Parachute Rigger to insure that proper gear is prepared for all aircraft. Survival equipment is useless to'the crew if it is in the parachute loft or on the hangar deck. Aircraft MUST be checked before takeoff to see that the required items are aboard and in good condition.

Other than the standard items which are part of the aircraft's inventory, the Navy has provided various droppable kits to be used for air-sea rescue. Some of these kits can be dropped in free-fall fashion, while others are too fragile for such rough treatment, and must be delivered by small cargo-type parachutes. There is no physical limit to the different kinds of equipment that can be rigged for emergency rescue operation. The mental limit, to a great extent, depends on the Parachute Rigger and how well he has prepared himself to cope with emergency rescue techniques.

There are a number of tailor-made droppable kits available through Supply. Descriptions of some of these kits, along with information concerning operation of the equipment, are included in this section.

AR-4 LIFEBOAT ASSEMBLY.—The AR-4 droppable lifeboat, designed for dropping to personnel, is a 4-man pneumatic life raft of double tube construction. It is complete with a lateen-type sailing rig, mast, rudder, keel, weather shield, sun canopy, sea anchor, and an inflatable floor. The weight of the unit, properly padded and protected for dropping, and ready for installation in the aircraft, is approximately 110 pounds. An instruction booklet is provided with each assembly, stowed in the starboard bow supply pocket. The booklet contains complete instructions for operating the boat, including all equipment. Figures 2-10 and 2-11 illustrate the AR-4 droppable lifeboat assembly.

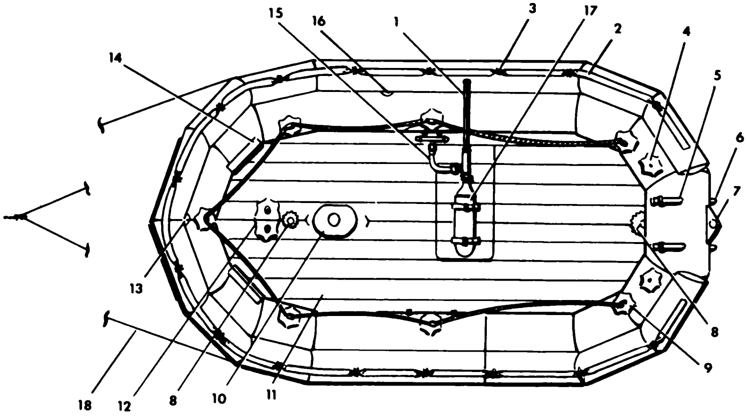


Figure 2-10.—AR-4 lifeboat.

1. CO$_2$ valve cable.
2. Weather shield.
3. Weather shield tiedown.
4. Patch for sheet lead.
5. Motor mount buckle straps.
6. Fabric loops for motor mount.
7. Rudder lock.
8. Socket to receive oar length.
9. Lifeline patch inboard.
10. Sleeve for mast insertion into keel.
11. Inflatable floor.
12. Valves for 2-compartment floor.
13. D-ring for bow mast stay.
14. Stowage pockets.
15. CO$_2$ hose assembly.
16. D-ring for starboard mast.
17. CO$_2$ cylinder and valve.
18. Sea anchor bridle.

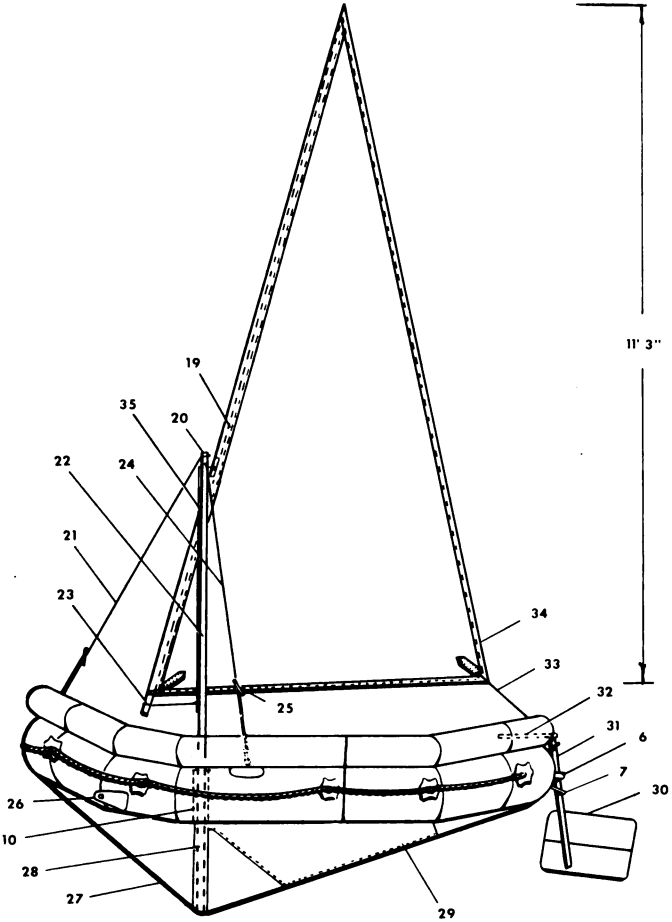


Figure 2-11.—AR-4 lifeboat rigged for sailing.

19. Yardarm sleeve in sail.
20. Mast stay and halyard fitting.
21. Bow mast stay.
22. Mast.
23. Yardarm.
24. Stay.
25. Stay adjustors, wooden.
26. Sea anchor D-ring.
27. Keel cable.
28. Fabric sleeve to receive mast.
29. Fabric keel.
30. Rudder, hinged through supports.
31. Rudder post.
32. Tiller.
33. Sail sheet lead.
34. Sail.
35. Halyard.

A 2-compartment removable inflatable floor is inflated through the topping-off valves provided. The side of the floor is designed so that it will not chafe the flotation tube of the boat. Removed it can be used, as an auxiliary means of flotation.

Only the main flotation tube is inflated with carbon dioxide. The remaining inflation chambers (spray tube and floor) must be inflated with the hand pump. A wrench, suitable for detaching the CO_2 cylinder from the boat, is securely attached adjacent to the cylinder.

A mast yardarm is formed from sections of oars which are the same as those used in the standard-type multiplace rafts. The mast is made up of one section of the A length and four sections of the B lengths. Section C lengths are used with any of the other sections when oars are needed.

One wooden fitting is supplied to fit the top of the mast to hold the three mast stays and receive the sail halyard as shown in figure 2-11.

The D-ring assemblies for the mast stays consist of 1-1/4-inch cadmium-plated D-rings secured to type O fabric patches by lengths of nylon webbing 1 inch wide. The webbing passes through the ring and is stitched to fabric patches. These rings, when installed, must be able to withstand a straightaway pull of at least 300 pounds.

The mast halyard cleat is a metal cleat designed for attachment by clamping to the mast. It is used for securing the sail hoist and yardarm securing lines.

The sail material is made of 2-ounce sailcloth. It is blue, and the sail is equipped with a fabric sleeve to receive the yardarm.

A collapsible wooden rudder folds lengthwise through the middle, on hinges.

No motor is supplied with the assembly; however, it is equipped to receive one of low horsepower.

The lifeboat is packed in the carrying case. The outer color of the case is orange-yellow. In accordance with specifications, the case consists of an outer ply of type II fabric backed up by a ply of 8-ounce cotton duck. The ends are closed by snap fasteners. The longitudinal opening is enclosed by a locking pin and cone assembly attached to the CO_2 valve cable by a snaphook fastener.

Two equipment containers are supplied with each lifeboat. The contents that are to be placed in each equipment container are marked on the containers in 1/4-inch letters. The AR-4 lifeboat equipment is listed in table 2-4.

ADA-2 ARCTIC SURVIVAL KIT.—The arctic survival kit was designed to be dropped by parachute from multiengine aircraft. Chest-type parachutes are easily engaged with the rings of a webbing yoke which holds and centralizes the other three encircling adjustable straps. Figure 2-12 illustrates one application of a chest-type parachute to the kit. Any cargo-type parachute of a suitable size, 24 to 28 feet in diameter, can be used in rigging this kit.

The purpose of the kit is reflected in the items it contains. Any of the following items can be added or eliminated for substitution purposes in accordance with local requirements:

Antichap lipstick.
C-3 rations.
AN/PRC-17 transceiver.
Bag, sleeping, M-1949.
Candles, 1-1/4 by 5 inches.
Cord, nylon (Type I), 50 feet.
Signal, distress, Mk 13 Mod O.
Drawers, wool, size 42.
File, 6-inch.
First aid kit, Aero.
Fishing equipment.
Flashlight.
Fuel, Sterno, No. 4006 in cans.
Mittens, Arctic, Mil-M-834-B.
Tablets, heating, fuel, Trioxane.
Stove assembly (R83-S-793070).
M6 rifle/shotgun 22 cal/410 & ammo.
Survival kit (axe and saw).
Batteries, flashlight.
Brush, mountain.
Survival Manual, NA 00-80T-70.
Frying pan.
Knife, survival with sheath.
Undershirts, wool, size 42.
Code, signaling.
Matches, waterproof.
Mosquito headnets.
Parkahood, detachable.
Paulin Mk 7.
Scarfs.
Signaling mirror.
Snare, self-locking size O.
Socks, wool, cushion sole, size 12.
Sun glasses, with case.
Tissue, facial.
Whistle.
Wire, copper, soft or annealed, 50 feet.
List of contents (ADA-2 kit).

ADSK-1 KIT.—This kit is designed to be carried on the bomb rack of fighter aircraft. It is shaped similar to a

Table 2-4.—AR-4 lifeboat equipment.

Article	Quantity	Furnished by	Installed by	Location
1. Anchor, sea	1	Contractor	Contractor	Boat package.
2. Bag, water, stowage	4	do	do	Survival equipment container.
3. Booklet, instruction	1	do	do	Starboard bow pocket of boat.
4. Bucket, bailing	2	do	do	Port bow pocket of boat.
5. Cleat, mast halyard	1	do	do	Sailing equipment container.
6. Compass, card type	1	do	do	Survival equipment container.
7. Container, equipment	2	do	do	Boat package.
8. Fitting, stay and halyard	1	do	do	Sailing equipment container.
9. Kits, desalting	4	Government	do	Survival equipment container.
10. Kits, repair	1	Contractor	do	Starboard bow pocket of boat.
11. Jackknife	1	Government	do	Survival equipment container.
12. Marker, dye pack	6	do	do	do
13. Mirror, signaling	1	do	do	do
14. Paulin	1	Contractor	do	do
15. Pump, hand	2	do	do	do
16. Reflector, corner*	1	Government	Government	do
17. Rudder	1	Contractor	Contractor	Sailing equipment container.
18. Sail	1	do	do	do
19. Sections, oars, mast, yardarm	2 Sec. A	do	do	do
	6 Sec. B	do	do	do
	2 Sec. C	do	do	do
20. Signals, distress (day and night)	3	Government	do	Survival equipment container.
21. Sponge, bailing	1	do	do	do
22. Stays, mast	3	Contractor	do	Sailing equipment container.
23. Whistle	1	Government	do	Survival equipment container.

*When available, the Transceiver, Model AN/PRC-17, shall be substituted for the corner reflector.

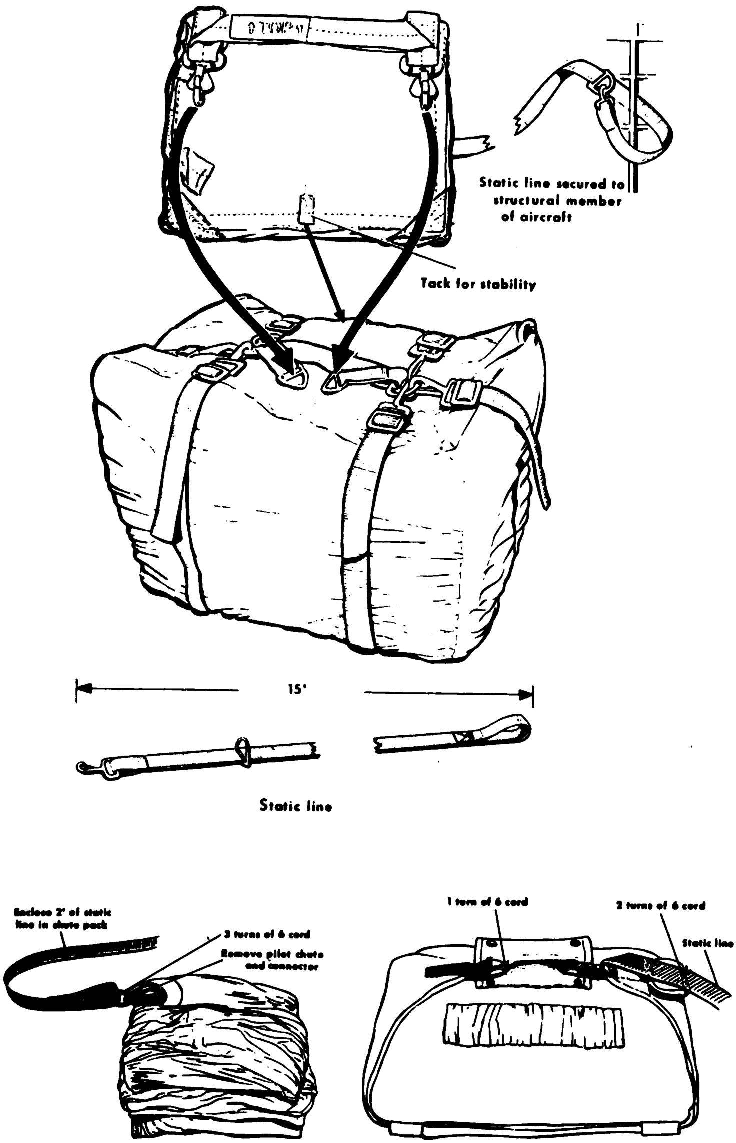


Figure 2-12.—Rigging and dropping the ADA-2 arctic survival kit.

bomb, and is dropped by a 9-foot parachute packed in one end of the container. It can be dropped at speeds up to 250 miles per hour. The contents of the kit are about the same as its counterpart which is dropped from multiengine aircraft.

ADR-1 RATION KIT.—This kit is designed to provide distressed personnel a maximum amount of water so they can maintain the pint of water a day considered the minimum requirement for survival. The size of the kit when packed is 21 x 8 x 6 inches. It can be carried and dropped from any type aircraft. No special dropping technique is required to release the kit from the aircraft as it is small enough to be thrown from a cockpit. When the kit is to be dropped, the aircraft should approach the area as slowly as possible, 90 to 100 indicated air speed, and at about 100 feet altitude. The kit is buoyant and floats high in the water, and should be dropped upwind of survivors.

The ADR-1 ration kit contains four desalting kits, a water storage bag, solar still, jackknife, six ration tablet containers, and a length of cotton twine.

AN/CRT-3-A RADIO TRANSMITTER.—The AN/CRT-3 emergency radio transmitter (Gibson Girl) is used to transmit distress signals and is carried in most multiengine aircraft. (See fig. 2-13.) It is also carried in all rescue aircraft and can be dropped to survivors by means of a parachute attached to the container. The container holds the transmitter with the crank attached, a collapsible box kite, signal light, two hydrogen generators, two transfer units, two balloons, and two spare aerials. The transmitter has a range up to 1,600 miles, depending on atmospheric conditions.

If at all possible, the transmitter should be dropped over water, as the possibility of damage to the transmitter is very great when dropped on land. When the transmitter is dropped, the aircraft should be slowed down to its slowest safe speed and the transmitter dropped at 300 to 500 feet. The direction of drift should also be taken into consideration when making the drop. If the transmitter is dropped to men in the water, it should be dropped upwind; to men in a life raft, downwind. In case more than one item is to be dropped, they should be tied together.

If the aircraft is ditched, the transmitter should not be tossed out until the aircraft comes to a complete stop, for

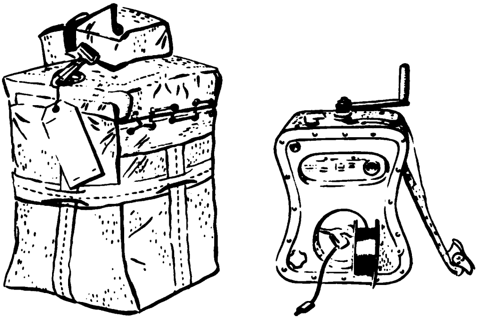


Figure 2-13.—AN/CRT-3-A (Gibson Girl) emergency radio transmitter.

there may be more than one impact. When the aircraft has stopped, the container should be thrown out an escape hatch. It will float and can be picked up after other equipment has been removed and the life raft has been boarded.

There are two means of raising the aerial—either by the kite or the balloon provided. If there is enough wind, the kite should be used; if there is no wind, the balloon should be used. The aerial should never be left up during an electrical storm, as severe injuries to personnel may result from lightning striking the aerial.

To set up the transmitter for operation on water, the transmitter is removed from the container and the ground is removed, unrolled, and dropped into the water. The cotter key is then removed from the face of the compartment door. With the door fully open, the door is locked with the cotter key.

If the kite is to be used, it should be removed from the container and assembled according to the printed instructions. The speed of the wind should be estimated and the aerial secured to the kite either at the point marked "winds 7 to 15 miles per hour," or at the point marked "winds 15 to 40 miles per hour."

If the balloon is to be used to raise the aerial, it must be inflated by using the hydrogen generator. The small end of the transfer unit is inserted into the neck of the balloon, making sure that the transfer unit is inserted fully. The end of the generator marked TOP should be opened, using the key supplied with the generator. The threaded end of the transfer unit is screwed into the threaded depression in the center of the generator. After the bottom of the generator has been removed with the key, the generator is inserted into the water until the water is even with the top of the generator. It might be necessary to shake the generator slightly to get water into the carbide to begin action. PERSONNEL SHOULD BE CAUTIONED NOT TO SMOKE WHILE THE BALLOON IS BEING FILLED AS HYDROGEN IS EXPLOSIVE. It will take approximately 30 to 40 minutes to remove all the gas from the generator. When the generator stops generating, the transfer unit is removed and thrown away, as the residue is caustic and will cause burns. The aerial is then attached to the balloon and the aerial payed out. Speed can be controlled by the brake on the drum. The brake is turned clockwise to tighten and counterclockwise to let the drum run free.

When the antenna is up, the operator should secure the transmitter by placing it between his legs, securing it with the strap run under the legs.

NOTE: The antenna contact wire from the main body of the radio, located in the antenna well, must be attached to the extended antenna.

The AN/CRT-3 transmitter has a selector switch and three positions marked 8364 and 500 KILOCYCLES, MANUAL, and LIGHT. By placing the selector switch at 8364-500 and turning the crank 80 to 100 r.p.m., an automatic SOS will be transmitted, alternating 40 seconds on 8364 and 40 seconds on 500 kc. When the generator light is on, it indicates that maximum voltage of 24-31 has been reached, and it will do more harm than good to crank any faster. The probable daytime range of 8364 will be between 500 and 750 miles. The nighttime range may be increased greatly.

When transmitting on 500 kc. at sea under ideal conditions, the transmitter has a range of 250 to 500 miles. Transmitting on land, the range may be reduced to as much as 5 to 10 miles.

By placing the selector switch at the manual position, a message or steady tone can be transmitted by using the key on the left side of the transmitter. By plugging the signal light in the transmitter and turning the selector switch to light, a steady light can be obtained or a blinker can be sent by using the key.

The international distress frequency is 500 kilocycles. International law requires that all ships and stations maintain silence and guard this frequency for two 3-minute periods during each hour. The international silent period is from 15 to 18 minutes past the hour and 45 to 48 minutes past the hour.

For selection of terrain and choice of setup, reference should be made to the instruction booklet provided with each transmitter.

AN/PRC-17 TRANSCEIVER.—The transceiver was designed to be dropped to survivors behind enemy lines.

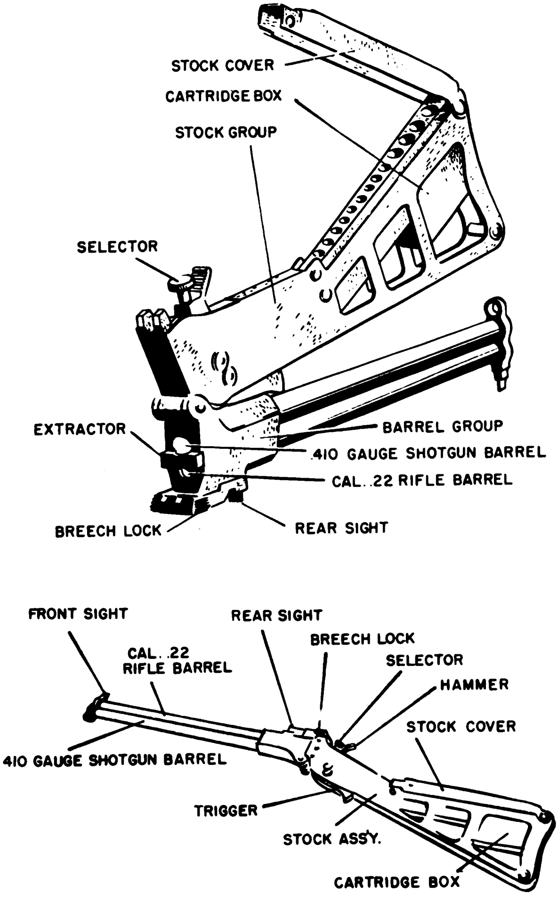


Figure 2-14.—M6 rifle/shotgun.

It is used to communicate with covering rescue aircraft and to help direct helicopters in making a rescue pickup. However, the Navy is using it primarily to replace the radar corner reflectors in pararafts and multiplace life rafts.

M6 RIFLE/SHOTGUN.—The rifle/shotgun is included as an item in certain survival kits. It serves as a weapon for hunting various kinds of game. The M6 rifle/shotgun is illustrated in both partially folded and fully extended positions in figure 2-14.

QUIZ

1. A reasonable maximum workload per day for one packing table is approximately____ parachutes.
   a. 15
   b. 25
   c. 30
   d. 35
2. In the dry locker, a 28-foot parachute, suspended freely, requires a height of approximately____feet.
   a. 35
   b. 40
   c. 45
   d. 50
3. For adequate drying of parachutes, the hoisting lines in the dry locker suspending the parachutes should be a minimum distance of____inches apart.
   a. 6
   b. 12
   c. 18
   d. 24
4. The recommended chemical for absorbing moisture in the dry locker is
   a. aero-gel
   b. anhydrous calcium sulphate
   c. sodium chloride
   d. magnesium chloride
5. The ideal temperature for storage of parachutes is
   a. 65° F.
   b. 70° F.
   c. 74° F.
   d. 80° F.

6. The maximum temperature for any space is
   - a. 100° F.
   - b. 110° F.
   - c. 120° F.
   - d. 130° F.

7. The sling psychrometer should be rotated at a speed of approximately____ r.p.m.
   - a. 80
   - b. 100
   - c. 120
   - d. 140

8. The humidity element of the hygrothermograph consists of
   - a. 50 strands blonde human hair
   - b. 50 strands combed rayon
   - c. 50 strands red human hair
   - d. 70 strands blonde human hair

9. The minimum breaking strength of size E nylon thread is____pounds.
   - a. 5.5
   - b. 8.5
   - c. 16
   - d. 24

10. The minimum breaking strength of size A nylon thread is____pounds.
    - a. 1.1
    - b. 2.1
    - c. 2.75
    - d. 3.2

11. The minimum breaking strength of 3-cord nylon is ______ pounds.
    - a. 14
    - b. 18
    - c. 22
    - d. 24

12. Type I thread is a
    - a. twisted, bonded multicord thread
    - b. machine twist thread
    - c. triple braided thread
    - d. single braided thread

13. The maximum weight of 1 square yard of canopy fabric is
    - a. 0.18 ounce
    - b. 0.93 ounce
    - c. 1.1 ounces
    - d. 1.9 ounces

14. FUR forms are ordered on Publications and Forms Order Blank
    a. NavAer 129
    b. NavAer 136
    c. NavAer 140
    d. NavAer 144

15. Maintenance usage data is submitted to ASO
    a. weekly
    b. monthly
    c. quarterly
    d. annually

16. The stub requisition used for drawing material afloat is
    a. S. and A. 307
    b. DD 1170
    c. DD 1150
    d. S. and A. 306A

17. Manuals on parachutes and personal equipment are in the____series of aeronautical publications.
    a. 13
    b. 15
    c. 24
    d. 51

18. Information relative to the emergency escape procedures for any given type aircraft can be found in the
    a. Maintenance Instructions Handbook
    b. Flight Handbook
    c. Pilots Flight Log
    d. Parachute Manual

19. When making a water landing, the primary object on entering the water is to
    a. inflate the life vest
    b. inflate the life raft
    c. get free of the harness
    d. save the parachute

20. The weight of the AR-4, equipped, is approximately _____ pounds.
    a. 84
    b. 95
    c. 106
    d. 110

21. On the AR-4, CO_2 is used to inflate the
    a. main flotation tube
    b. inflatable floor
    c. fabric keel
    d. spray tube

22. The ADSK-1 is dropped with a____foot parachute.
   a. 6
   b. 9
   c. 12
   d. 16

23. The ADR-1 is dropped from a recommended altitude of____feet.
   a. 100
   b. 150
   c. 200
   d. 250

24. The AN/CRT-3 emergency radio transmitter is known as the
   a. walkie talkie
   b. Marilyn Monroe
   c. Gibson Girl
   d. radio phone

25. The AN/CRT-3 operates on the following frequencies
   a. 8280-500
   b. 8364-480
   c. 8360-500
   d. 8364-500

CHAPTER 3

TESTING AVIATOR'S BREATHING OXYGEN

AVIATOR'S BREATHING OXYGEN

Oxygen is nature's most plentiful element. It forms about 23 percent by weight and about 21 percent by volume of the atmosphere. Under ordinary atmospheric conditions at sea level, there is no respiratory problem; however, at high altitudes, above 10,000 feet, the partial pressure of oxygen diminishes. To overcome the rarefied atmospheric conditions associated with high altitude flight, some means of extracting oxygen from the air had to be found.

Some aviator's breathing oxygen is prepared on a commercial scale by the electrolysis of water. This method is expensive, but the demand for hydrogen, which is also produced during electrolysis, makes it worth while commercially. However, the large scale production of breathing oxygen is based on the physical process of distilling liquid air.

Oxygen for use in aircraft must be pure and dry. The importance of this fact cannot be overemphasized. Lives may depend on it. Since it is so important to have pure, dry oxygen, a system of regular tests must be made to insure that breathing oxygen meets the required standards and that it remains that way until ready for use.

A person cannot see, feel, taste or smell oxygen gas. How, then, can we determine so much about it? The purpose of this chapter is to introduce the laboratory instruments (water vapor indicator, purity analyzers, and others) necessary for inspection. Moreover, it also instructs the Parachute Rigger in the procedures involved in conducting the inspection. Before proceeding with the subjects of instrumentation and analysis, a survey of the specifications of oxygen gas and liquid oxygen will follow.

OXYGEN—GAS AND LIQUID

SPECIFICATIONS.—Specifications used by the Bureau of Aeronautics are listed primarily in alphabetical and numerical form. The index is entitled, *List of Military Specification and Standards Used by the Bureau of Aeronautics*. Manufacturers under government contract are required to use these specifications, among other directives, in making their products. The specification, a document designed in accordance with exact principles simply states what is wanted in a product. With respect to how it is to be done, this factor often rests with the manufacturer. Of course, some specifications allow little or no latitude, and this type is very precise in every detail. With respect to the manufacture of aviator's breathing oxygen, the specification is precise.

Here are some of the statements and factors involved:

1. Oxygen is furnished in two types and three different grades. With type I oxygen, which is a gas, there are three grades. Grade A is for aviator's breathing purposes, grade B is for industrial and medical use. Under type I, grade C is the only one that need not conform with U.S.P. (U.S. Pharmacopeial) requirements since it is not intended for consumption; however, this does not affect its percentage of oxygen content. This is not a contradiction. While this grade is odorless and free from adulterants, it is not free from certain contaminants because of its more liberal usage. Type II oxygen is a liquid, and when gasified must be as pure and free from water content as type I, grade A oxygen.

2. Type I, all grades, contains not less than 99.5 percent oxygen by volume. Type I, grade A oxygen contains not more than 0.02 milligrams (see metric tables) of water vapor per liter of gas at 70° F., and 760 millimeters of mercury pressure, when tested as described in the specification.

3. The presence or absence of odoriferous gases is determined by cracking the cylinder valve and smelling the escaping gas. Pure oxygen is odorless and tasteless. Any odor detected is cause for rejection.

From this we can conclude that breathing oxygen for aviators must be extremely dry to avoid any possibility of moisture freezing in valves or lines with consequent stoppage of the flow. Grade A oxygen is the same as grade B oxygen except grade A has less moisture. Grade A oxygen can be used where grade B is required for all purposes, but grade B CANNOT be used in lieu of grade A for aviator's breathing. Grade C may not be used where grade A is required, nor for medical purposes.

The test for purity (according to U.S.P.) requires the use of freshly prepared ammonium chloride-ammonium hydroxide solutions. This extremely accurate chemical process measures the volume of residual gas remaining undissolved in a nitrometer tube. A description of this test and the equipment and materials involved are described in National Bureau of Standards Research Paper 266 or Pharmacopeia of the United States of America U.S.P. XIV. Furthermore, additional similar information is contained in *Field Manufacture of Industrial Gases,* NavPers 10078.

WATER VAPOR INDICATOR

Until recently, measurement of small amounts of water vapor in gases has been limited chiefly by lack of apparatus sufficiently simple and compact to be used by technicians in the field. During World War II an apparatus for determining minute quantities of water vapor in compressed aviator's breathing oxygen was devised and constructed. Besides being capable of testing compressed oxygen for small quantities of moisture, the Aminco-Weaver Water Vapor Indicator (fig. 3-1) is also capable of testing many other gases for the same condition. Gases in which water vapor can be measured, to name only a few in addition to oxygen, are: air, carbon dioxide, nitrogen, helium, and carbon monoxide.

Instruments of this type are used in chemical laboratories, government field stations, industrial plants, and educational institutions. The primary use as far as the

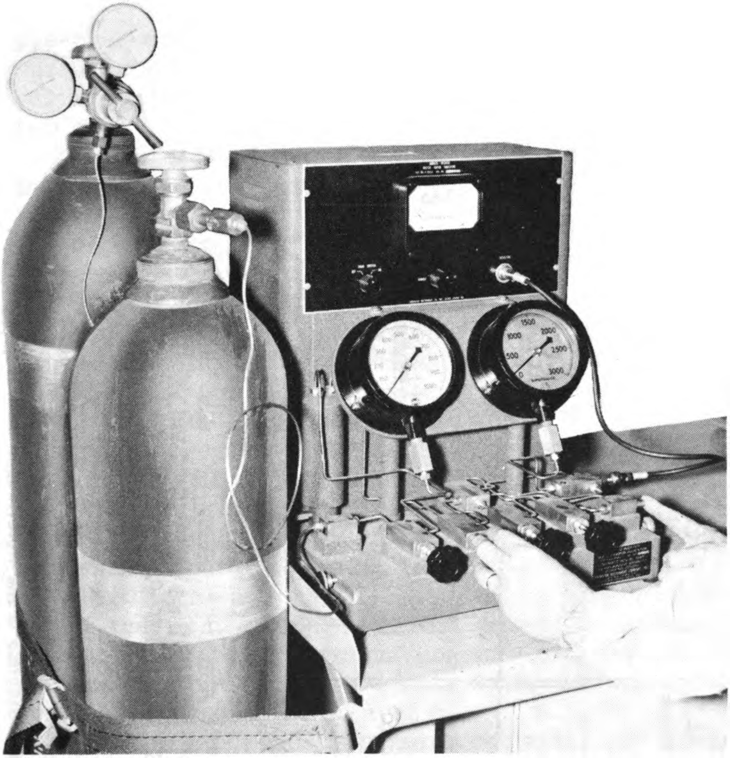


Figure 3-1.—Aminco-Weaver Water Vapor Indicator, in use.

Parachute Rigger is concerned entails the application of the instrument to determine the amount of water vapor in breathing oxygen.

PRINCIPLES OF OPERATION.—The Aminco-Weaver Water Vapor Indicator, hereafter called the water vapor indicator or instrument, is shown in schematic diagram form in figure 3-2. Water vapor content of the test gas is determined through comparison with the water vapor content of a standard gas, saturated under pressure and expanded to atmospheric pressure.

A measure of the water vapor content of the standard gas (gas supply connected to saturator) is derived by using a moisture sensitive detector. The pressure of the test gas is adjusted until a like indication of the detector is attained. The pressure of the saturated gas, Pa, test

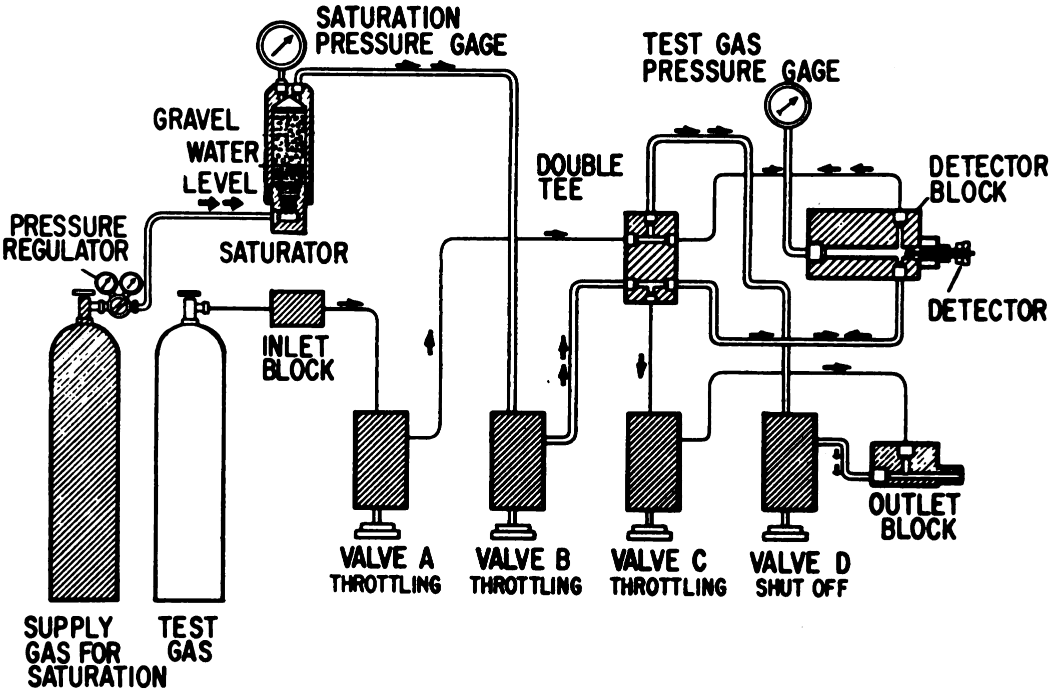


Figure 3-2.—Schematic diagram of the water vapor indicator.

gas pressure, Px, altitude, and ambient (prevailing and surrounding) temperature are related using the moisture calculator for determining the water vapor content of the test gas.

The tip of the detector, which is exposed to moisture laden gas, is coated with a thin hygroscopic film of electrolyte. In operation, water molecules impinge upon this film and the number striking it determines the electrical resistance of the film. Acting in this capacity, the moisture sensitive detector constitutes one arm of an a-c bridge. (The principles of an electrical bridge are discussed and illustrated in *Basic Electricity*, NavPers 10086. A vacuum tube voltmeter is used to determine unbalanced conditions in the bridge where the detector is serving as one arm of the arrangement. The indicating micrometer will show resistance changes in the detector tip. Therefore, the meter reading changes if the water vapor content of the gas changes. An audio oscillator furnishes a-c power to the bridge circuit. Batteries (two 45-volt batteries and one 1-1/2-volt battery) are contained within the unit, making external power unnecessary. Mechanically, the instrument consists of equipment to produce a standard gas of known water content and to control the pressure of the test gas.

The water vapor indicator measures water vapor content of compressed gases within the range of 0.005 to 1 milligram per liter computed at 80° F. and atmospheric pressure. The accuracy of the instrument is ±10 percent of the amount of water vapor present.

DESCRIPTION.—The indicator consists of a main assembly shown in figure 3-3, while its accessories are shown in figure 3-4. The main assembly includes the electronic chassis and control panel, saturation and test gas pressure gages, saturator, double-tee inlet, outlet and detector blocks, and four control valves. The accessories can be stored in a cabinet which is in back of the main assembly.

The controls of the instrument and their functions follow:

MAIN SWITCH—a two-position switch. When in the OFF position, the equipment is inoperative; when in the ON position, it connects the batteries making the equipment operative.

METER ADJUSTER—Adjusts indicating meter to any value whether the detector is connected or not.

VALVE A—adjusts the flow of gas from the test gas cylinder to the detector block.

VALVE B—Adjusts the flow of gas from the saturator to the detector block.

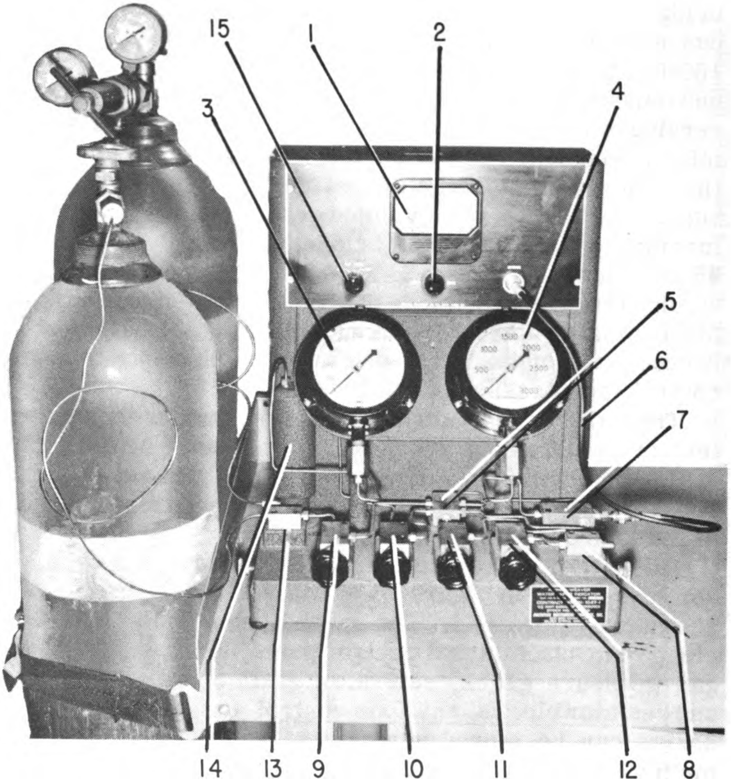


Figure 3-3.—Front view of water vapor indicator—cover removed.

1. Meter.
2. Meter control adjuster.
3. Saturation pressure gage.
4. Test gas gage.
5. Double tee.
6. Cable.
7. Detector block.
8. Outlet block.
9. Valve A.
10. Valve B.
11. Valve C.
12. Valve D.
13. Inlet block.
14. Saturator.
15. Main switch.

VALVE C—adjusts the flow of test gas from the detector block to the gas outlet block.

VALVE D—adjusts the flow of standard gas from the detector block to the gas outlet block.

The functions of the dial instruments follow:

METER—indicates resistance of detector. If the meter adjustment control is not changed, and resistance of the detector is constant, the meter reading remains unchanged.

SATURATION PRESSURE GAGE—indicates pressure in the saturator.

TEST GAS PRESSURE GAGE—indicates pressure in the detector block.

OPERATING PROCEDURE.—Operating steps follow:

1. Unscrew and remove the four cover retaining screws and remove the cover. Remove the sheet metal screws in top of electrical indicator and remove the top. Remove the meter shorting wire which bridges the two terminals in back of the meter. Connect meter leads and replace the top.

2. Remove accessories from back of instrument.

3. Connect the pressure reducing regulator to the supply cylinder of the standard gas supply. Next, connect one end of the pressure reducer-saturator line by screwing the end fitted with the long nut into the bottom of the saturator. Use wrench (13, fig. 3-4) to complete tightening nuts on 1/8-inch tubing. Designed to prevent stripping the threads when tightening such connections, this wrench offers limited leverage possibilities.

4. Connect valve adapter to the test gas cylinder valve; follow this by engaging the cylinder-inlet-block line between the valve adapter and the inlet block connections.

5. To add water to the saturator, disconnect the two lines leading into its top, thus exposing the threaded holes. Fill pipette with DISTILLED WATER (about 20 ml. (milliliter)) by sucking on the glass tip while the end of the rubber tube is immersed in the water. When the quantity is reached, quickly trap the water, in the pipette and clamp the end of the rubber tube with the finters. Transfer the liquid into the saturator through the hole used to connect the saturator to the saturation pressure gage. IF ANY WATER ENTERS THE OTHER HOLE CONNECTION, IT MUST BE REMOVED. This can be accomplished

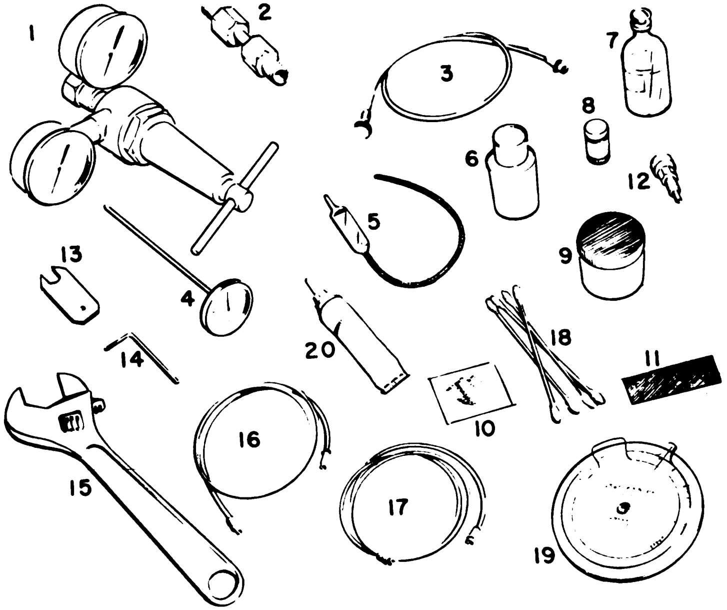


Figure 3-4.—Instrument accessories.

1. Pressure regulator—used to regulate pressure in saturator.
2. Oxygen valve adapter—used to adapt oxygen valve outlet nut to standard 3/8-inch diameter nut.
3. Cable—used to connect detector to electrical indicator.
4. Thermometer—used to measure ambient temperature around equipment.
5. Pipette—used for adding water to saturator (With care, a hypodermic syringe fitted with a long needle can also be used).
6. Phosphoric anhydride—forms phosphoric acid (alternate electrolyte) when exposed to water. The resulting acid is a syrupy hygroscopic liquid and is placed on the detector when moderately dry gases are being measured for water content.
7. Electrolyte—this liquid is made up of 3 parts phosphoric acid and 2 parts sulphuric acid; it serves as hygroscopic material when placed on tip of the detector (varies in resistance with water vapor content of gas surrounding it). Used when very dry gases are being measured for water content. (Aviator's breathing oxygen is supposed to be very dry for reasons already familiar to Parachute Riggers, First Class.)
8. Vial—used to protect expensive and delicate detector.
9. Jar—used to hold aloxite grinding compound.
10. Grinding compound—aloxite fine grinding compound grit No. 95, used to grind tip of detector.

Nomenclature for Figure 3-4—Continued.

11. Grinding plate—used to hold grinding compound while grinding detector tip. (Any microscope glass slide may be used.)
12. Detector—used to detect water vapor, and must be handled with care.
13. Wrench—used to tighten nuts on flow assembly and tighten detector in block.
14. Wrench—used to remove valves, detector block, gas outlet and inlet block, double tee, and saturator from base.
15. Wrench—used to tighten pressure regulator to cylinder of supply gas for saturator, to tighten oxygen valve adapter to test gas cylinder, and to tighten gland nuts of valves A, B, C, and D.
16. Pressure reducer – saturator line—used to connect pressure regulator to saturator.
17. Cylinder-inlet-block line—used to connect oxygen cylinder to inlet block.
18. Applicators—cotton tipped wooden sticks, used to apply and remove excess electrolyte from detector.
19. Moisture calculator—used to calculate moisture content of test gas.
20. Grease—Dow Corning 33 grease of medium consistency used to grease threads and tips of valves A, B, C, and D whenever instrument has been disassembled for baking out or cleaning.

by swabbing out the water with cotton tipped applicators, a slow process, but one that must be accomplished. Replace and tighten the lines removed from the saturator. Figure 3-5 illustrates a cross sectional view of the saturator.

6. Connect the free end of the pressure reducer-saturator line to the pressure reducer.

7. Apply electrolyte sparingly by dipping the wood end of the applicator in the compound and touching it to the tip of the detector. A small ball of the electrolyte will be formed. To remove excess acid, make two or three light pressed strokes over the tip of the detector with the cotton end of the stick. When the excess has been removed sufficiently, the tip will appear dull but not quite dry. The film thickness remaining on the detector is not critical. One film might offer five times the resistance of another, but their difference would be hardly noticeable in use. Break off the tip of the stick so it will not come in contact with the person or clothing. One applicator can be used repeatedly by breaking off the previously applied portions. To minimize spillage, use only

a small quantity of the acid in the bottle at any one time.

8. Insert the detector into the detector block and tighten it with the stubby wrench.

9. Close all valve blocks (A, B, C, and D).

10. To prevent a pressure surge from blowing water out the saturator into the dry lines and valve blocks, release the pressure adjusting screw on the pressure regulator by rotating it counterclockwise until it spins freely. Caution: Careless valve handling procedures will dampen or saturate the system, making it necessary to strip and bake the lines and blocks before the instrument can be reset for use. Therefore, make it a habit to open all valves very slowly. Crack (open a fraction of a turn) the cylinder valve of the saturator gas supply. After the cylinder pressure gage stops indicating, open the valve fully.

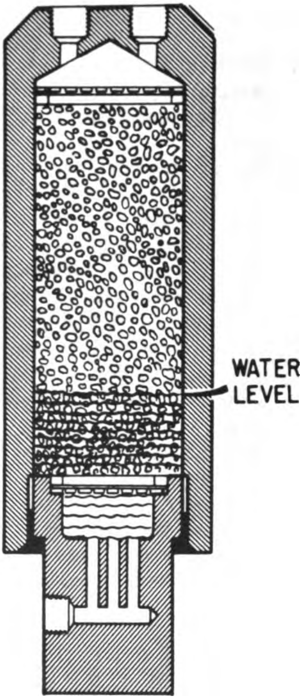


Figure 3-5.—Saturator.

11. Rotate the adjusting screw on the pressure reducing regulator, and slowly build up the pressure in the saturator to 700 p.s.i. as indicated on the pressure gage. Pressure up to 1,000 p.s.i. has been found to offer a reliable testing pressure. Here, too, smooth operation in the pressure buildup procedure is important to prevent blowing water into the lines.

12. Open valve D completely.

13. Open valve B about 1/8 of a turn; gas should now be flowing slowly from the outlet block. Adjust the valve so that the flow of gas is BARELY NOTICEABLE, emerging from the outlet. To test the adjustment of the very low flow which is nearly imperceptible, block the outlet with the finger. After a few seconds of blocking the outlet, and if there is a flow in the system, the pressure will

have increased enough for the gas to gust out perceptibly as the finger is removed. (This action, which is very slight, will not cause the water in the saturator to be syphoned into the system.) The reason for setting a low flow rate is to establish a gas pressure which is nearly atmospheric. When the lowest perceptible flow has been obtained, it is assumed to be atmospheric; although this is not exactly true (since atmospheric pressure is static), the calculation of water content will not be affected. Figure 3-6 illustrates the flow pattern through valves B and D of the system with valves A and C closed.

14. Engage ends of the cable in the electrical indicator socket and in the detector.

15. Turn the main switch ON. The meter will probably read off scale, either below 0 or above 50. The electrical indicator is designed so that no combination or adjustment of the meter control and the resistance of the detector will burn out the meter. Rotate the meter control knob until the meter reads on scale. Continue the adjustment until the needle is pointing to the midscale position, 25. (The reading of 25, or any other scale reading obtained while testing gas under pressure, is an indication or measurement of resistance. Therefore, the value indicated by the meter is only relative to the problem. Further calculation is necessary before the water vapor content, in milligrams per liter, can be determined.)

16. Check the sensitivity of the film by blocking the gas outlet, thus increasing the pressure in the detector block. Under these conditions, the meter reading should advance immediately above 50. When the finger (blocking the outlet) is removed, the meter should return to approximately 25. It may not return exactly to 25, since the meter reading is expected to drift slowly downscale. Occasionally a little condensed water will come through valve B, producing momentary increases in the meter reading. These brief deflections should be disregarded.

17. Readjust meter to a convenient ON SCALE position. For purposes of illustration, 25 or the midscale position, has been chosen as the example. This reading is known as the BALANCE POINT. ONCE THE BALANCE POINT HAS BEEN CHOSEN, DO NOT MOVE THE METER ADJUSTING CONTROL UNTIL THE TEST IS COMPLETED. Turn off the MAIN SWITCH.

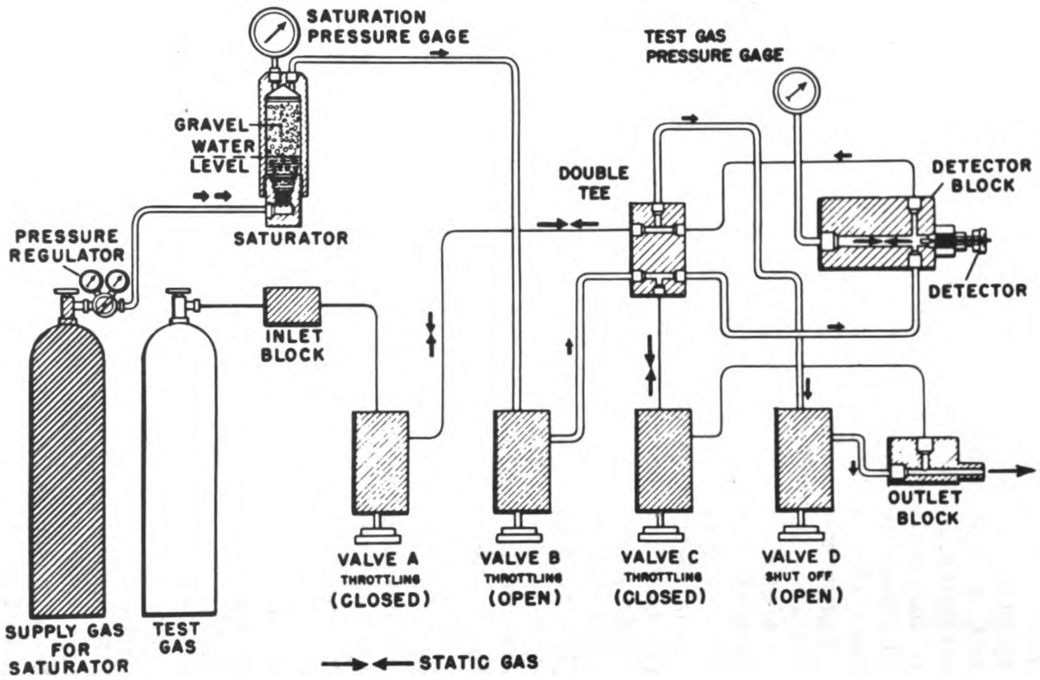


Figure 3-6.—Flow pattern of saturated gas with valves B and D open and valves A and C closed.

18. Close valve B, then valve D. Closing these valves in the reverse order of opening them prevents the saturated gas from building up pressure in the detector block and disturbing the balance point.

19. To use the calculator illustrated in figure 3-7 apply the following example:

a. Using the large tab on the calculator, set the saturated gas pressure used (700 p.s.i.) opposite the present indicated temperature, for example, 80° F. When these figures have been matched, hold the tab in position to prevent slippage in the operation to follow.

b. Set the hairline of the index (narrow projecting tab) on 0.02. (Outer scale represents water content.) The

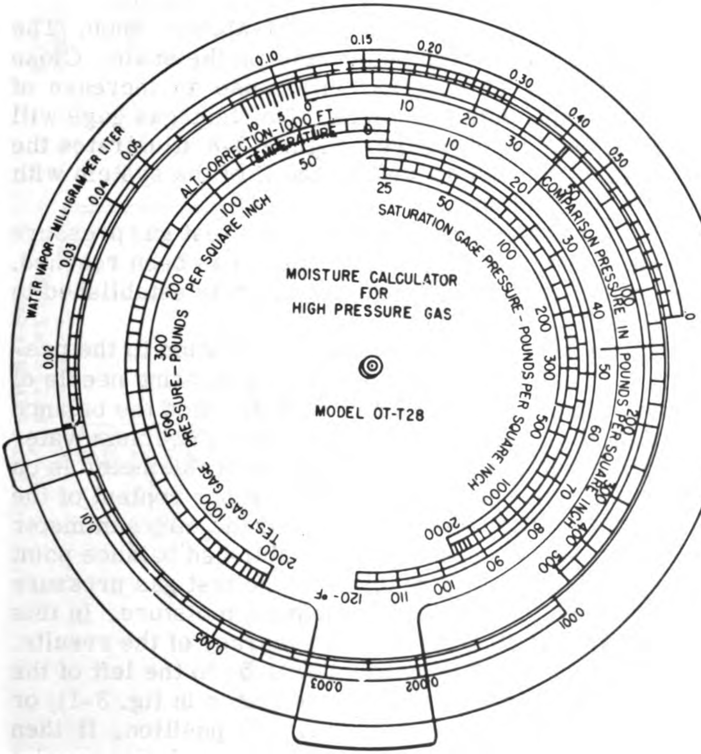


Figure 3-7.—Use of calculator when measurements are made at sea level.

figure 0.02 is familiar to all Parachute Riggers, and they should know immediately that the valve represented is the maximum allowable water vapor content in aviator's breathing oxygen.

c. Trace the hairline and where it intersects on the test gas scale, record the test gas pressure to be used. In this example, it reads 450 p.s.i.

Soon, in describing the operating steps involved in testing the test gas, the relationship of the figures given in this example to the meter reading will be understood.

20. Open the valve on the test gas cylinder.

21. Open valve C completely. This controls the gas flow through the outlet block.

22. Open valve A slightly. The gas should now be flowing from the outlet block. Turn on the microammeter switch without moving the "Adjust Meter" knob. The meter will probably read below zero on the scale. Close valve C slowly. This action will cause an increase of pressure in the detector block. The test gas gage will show this rise in pressure. Figure 3-8 illustrates the flow pattern through valves A and C of the system with valves B and D closed.

23. Continue closing valve C until the test gas pressure previously determined on the calculator has been reached. In the example, this pressure reading was established to be 450 p.s.i.

24. Observe the meter reading in relation to the previously set balance point, 25. If the indicating needle of the meter has not left 0 or has not reached the balance point of 25, the gas is within the specified maximum water vapor limit. If the indicating needle of the meter is on the balance point exactly, the water vapor content of the gas is 0.02 milligrams per liter. If the microammeter needle exceeds or passes the established balance point before the 450 p.s.i. is reached on the test gas pressure gage, the test gas contains excessive moisture. In this case repeat test stops to assure accuracy of the results. In most instances, the reading will be to the left of the balance point, (refer to gages and meter in fig. 3-1), or the needle will not move from the 0 position. It then follows that any reading between 0 and the balance point indicates the gas contains less than 0.02 milligram of water vapor per liter.

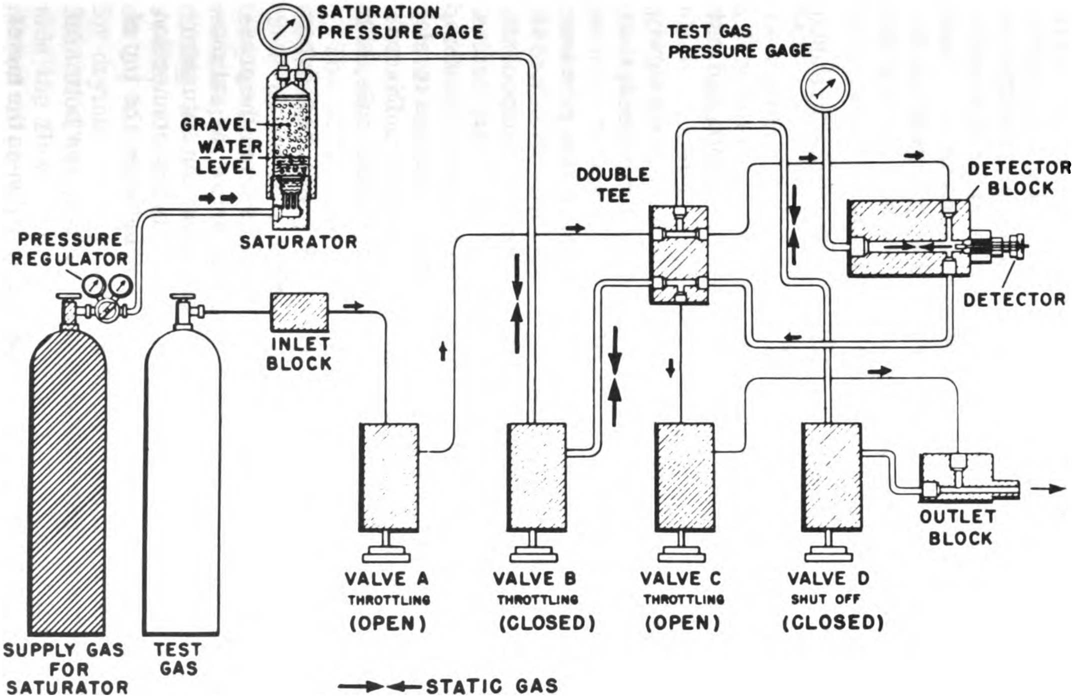


Figure 3-8.—Flow pattern of test gas with valves A and C open and valves 3 and D closed.

As a general practice, it is not necessary for the Parachute Rigger to know the exact water vapor content—all he needs to know is whether the test gas is within the maximum allowable limit. However, for an accurate accounting record, one which can be audited logically, figures are necessary. A neat and accurate record can provide valuable information and should be available. For a similar method, but one that leads to the exact calculation of the water content of the gas, refer to the manufacturer's *Handbook of Operation and Service Instructions for the Water Vapor Indicator.*

SHUTTING DOWN PROCEDURE.—The procedure used to secure the instrument follows:

1. Turn off the main switch.
2. Close the cylinder valves on the saturation and test gas supplies.
3. Loosen the test gas line at the inlet block slowly until the pressure trapped in the line is released; then break (disconnect) the connection.
4. Loosen the nut connecting the saturation pressure gage to the top of the saturator. This will allow gas to escape from the saturator and connecting components until the pressure is reduced to zero. (The zero reference applies to an ordinary pressure gage indication, since 14.7 p.s.i. is the atmospheric pressure at sea level.) Break the connection at the top of the saturator. Disconnecting the fitting will expose the threaded hole, and thereby aid the draining process later on.
5. Turn the adjusting screw of the pressure reducer counterclockwise until it spins freely.
6. Disconnect the saturation gas line from the pressure reducer. Hold the end of the line below the saturator and the distilled water will drain out the saturator. After the water is drained, replace the top connection which aided the process (connection between the top of the saturator and the pressure gage).
7. Remove the saturation gas line from the bottom of the saturator.
8. Disconnect the electrical cable between the meter and the detector. Remove the detector and clean the tip with cotton soaked in distilled water, then dry it thoroughly. Store the detector in the vial supplied for its

protection. If the detector is dropped, its internal insulation will be damaged, rendering it useless.

9. Close all valves located in the blocks. Stow accessories in the rear of the instrument and replace the cover, tightening it in place.

MAINTENANCE.—Preventive maintenance would probably be a more appropriate term for the heading of this section. Preventive maintenance procedures are directed to minimizing breakdowns of equipment. This is accomplished by scheduling periodic inspections and applying the necessary corrective action before the trouble begins.

The most universal application of preventive maintenance involves a relatively simple procedure—keeping the equipment clean. Since the water vapor indicator is a laboratory instrument designed for field usage, extra care must be exercised when moving it from place to place. Avoid jarring the instrument and scattering its accessories. The cover should be kept in place whenever the assembly is not in use. This simple practice is especially necessary when the area in which it is confined cannot be kept scrupulously clean. In any event, the best place for any laboratory apparatus, with due respect to its portability characteristics designed for field usage, is in a laboratory. Use a dry, clean, lint-free cloth or brush for cleaning the exterior of the equipment. For the removal of rust, use No. 0000 sandpaper or crocus cloth. When doing this, take precautions to prevent the entrance of foreign matter into any part of the system.

The instrument should be kept warm and dry. Cold equipment brought into a warm room will sweat and continue to do so until the equipment warms up to room temperature. This condition also arises when equipment warms up during the day after exposure to the atmosphere during a cold night. If the equipment is observed to sweat, valves (less knobs), detector block, gas inlet, gas outlet, and all connecting lines will have to be removed for drying. To dry, bake in an oven for several hours at 225° F. This procedure will remove the water from inside the flow assembly. Before the system (fig. 3-8) is placed in an oven, disconnect the tubes from the blocks and the other components, also disassemble the valves. Since the valve knobs would be damaged by oven heat, do not bake them with the rest of the components.

At any time during operation of the equipment, or under other conditions, water enters the detector block and connections, the test gas passing through the system would be nearly saturated. This would make a dry reading impossible. During operation, careless use of gas pressure and flows can cause the water in the saturator to be blown into the system. Since it takes hours to dry the components (fig. 3-8), a logical practice of maintaining a spare set of these items seems feasible. While the wet parts are being dried, the second set could be put into operation, thereby saving the valuable time that would otherwise be lost in the baking process.

Information relative to troubleshooting, grinding the detector tip, care of the electrical system, and other maintenance problems are discussed in detail in the manufacturer's *Handbook of Operation and Service Instructions for the Water Vapor Indicator* (NavAer 17-15BC-501). This handbook accompanies the equipment or can be ordered through publication channels. Before operation, read the instructions. Discuss those principles which are not understood clearly with personnel who are qualified to render assistance.

While understanding the theory of measurement (as applied to the Water Vapor Indicator) is not absolutely necessary for the successful operation of the instrument, anyone qualified to operate and service it should make an attempt to study the principles involved.

THE OXYGEN ANALYZER

How can we be certain breathing oxygen, a colorless, odorless, and tasteless gas, is pure (almost 100 percent pure)? Can we trust our senses of taste and smell when the gas we breathe has a peculiar odor or leaves an undetermined taste in the mouth? Even the cleanest aircraft oxygen systems affect the odorless characteristic of the gas it conveys. Airmen breathing through a system become conscious of the odor associated with that system. This odor (a mixture and blend of odors coming from rubber, copper, aluminum, brass, etc.), when only slightly noticeable, is not cause for alarm. One reason for this is that the men breathing oxygen feel safe in doing so. They take the purity of the gas for granted.

Do not misunderstand the meaning of the word purity, however. Purity can mean PURE POISON. When technicians in a laboratory seek the purity of a gas, they are searching for the percentage or partial pressure of a particular element in relation to others that may also be present in the given volume of gas under study. The point we are now ready to make is simply this: The Parachute Rigger, who is responsible for everything connected with breathing oxygen, cannot take things for granted, he cannot nor dare not, trust the manufacturing processes that are so remotely associated with his work. Too many things can happen between the time breathing oxygen is manufactured and transferred to an aircraft system. Oxygen, like food, is liable to the treacherous activities of a saboteur. Therefore, all things considered, the unit Parachute Rigger assigned to the field is the last link in a chain security.

Beckman Model E-2

This instrument is designed to provide an accurate and easily usable means of determining the partial pressure and corresponding percentage of oxygen in gaseous mixtures, or the purity of oxygen employed. To determine the partial pressure, which is a relative indication of the percentage of the gas, a comparison between a gas of known purity (reference gas) and one of unknown purity (sample or test gas) must be made. The Model E-2 was designed specifically to analyze mixtures containing a high percentage of oxygen. After proper standardization and under the recommended test specifications involving temperature, flow, pressure and moisture content, the analyzer is accurate to within ±0.5 percent of the full scale range. (See fig. 3-9.)

PRINCIPLES OF OPERATION.—The Beckman analyzer determines the oxygen partial pressure of a gas sample in the analysis system (magnet plate assembly) of the instrument by measuring the magnetic susceptibility of the gas with a magnetic torsion balance. Accurate oxygen analyses can be made of mixtures containing practically any of the other gases, since oxygen is strongly paramagnetic in nature (attracted into a magnetic field). A magnetic field is simply a space or area between the

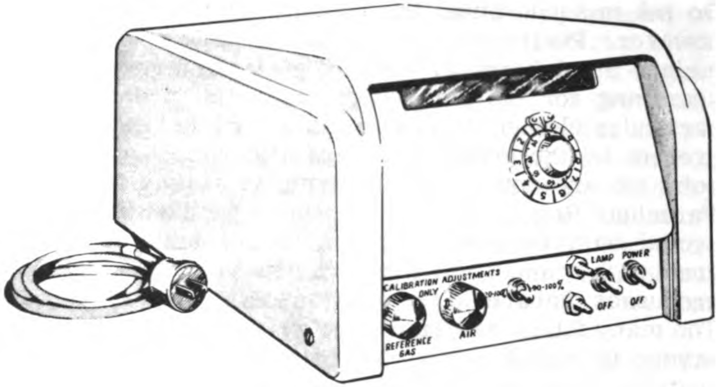


Figure 3-9.—Beckman Model E-2.

two poles of a magnet or set of magnets. When an element is paramagnetic, it is capable of a greater magnetization than a vacuum. This does not reveal much, but in comparison to something ferromagnetic (such as iron and nickel which is magnetic in a high degree), oxygen is not attracted in a strong degree. However, this does not prevent oxygen from being strongly paramagnetic in its own type attraction. For a complete understanding of this subject, a physics text should be studied.

No solutions or chemicals are used and the sample gas is unchanged in passing through the analyzer. The magnetic balance (torsion balance) consists of a mirror attached to a dumbbell-shaped test body which is supported by a quartz fiber. The test body is subjected to a magnetic rotational force and assumes a position dependent on the magnetic susceptibility of the test body and the properties of the gas. In addition, the overall physical design of the instrument is another factor considered. To attempt a lengthy discussion of the physical principles upon which the functioning of basic elements of the analyzer operate would exceed the purpose of a training course. In summary, by introducing gas, containing oxygen, into the instrument under a controlled rate of flow, the magnetic susceptibility present is changed by the unknown gas. Hence, the rotation of the test body assumes a new value.

The greater the percentage of oxygen in the gas (normally a Parachute Rigger is interested only in testing aviator's breathing oxygen for purity), the less will be the disturbance in the magnetic field. This is true because the instrument is balanced with nearly pure oxygen when it is prepared for testing. Furthermore, by setting a dial to read this unbalance, the comparative purity of the gas can be determined in a percentage value.

OPERATION.—The operation steps follow:

1. Turning on the power switch also illuminates a small neon pilot light which is visible in the right-hand corner of the screen. Thermoswitches automatically control the heating circuit of the instruments, and maintain the analyzer cell between 130°-140° F. The pilot light is off when the test cell has been brought up to the operating temperature. The minimum warming-up period required prior to operation is 30 minutes; however, for more accurate readings, a longer total period of 2 hours is recommended.
2. Set the range switch (located on front panel) in the 90-100 percent position.
3. Set the graduated dial (duodial 10 to 1 ratio) to the known purity value of the gas to be used as a reference. Commercial high-purity medical oxygen which has already been tested and certified should be used for this purpose. Oxygen of this quality is normally 99.8 to 99.9 percent pure!
4. Pass the reference gas of known purity through the flowrator at the side of the instrument. Then, pass it through the system by engaging a hose between the outlet of the flowrator and any one of the hose nipples on the front panel. The gas must be passed through the instrument at a controlled, fairly constant rate. This is accomplished by adjusting the valve on the flowrator until the internal float is centered (midway between top and bottom) in the tube. To protect the analyzer and the flowrator from damage, a very low rate of flow from the supply source must be used. Purging the instrument for two minutes (the minimum requirement) with the reference gas establishes a high-purity condition in the test cell. (This calibration fixes the scale after the gas has been passing for 2 minutes and the potentiometers are adjusted to center the light beam on the scale.)

5. Turn on the test lamp. The life of this lamp is a short 15 hours; therefore, use it only when necessary to make readings. Next, adjust the reference gas knob (located on the lower left side of the front panel) until the light beam is centered on the engraved line in the middle of the scale. Turn off the test lamp, also called the analyzer lamp (PR-12).

6. Set the range switch to the 20-100 percent position, and the duodial to 90.116. This setting corresponds to the 20.93 percent oxygen content of the dry air. Connect the tube from the rubber bulb on the drying tube to the nipple on the analyzer panel. Purge the analyzer completely with dry air by alternately squeezing and releasing the bulb for 2 minutes at an approximate flow of 200 cc. (cubic centimeter) per minute. When the blue indicating chemical in the drying cell of the bulb turns pink (after repeated use) replace the drying compound (silica gel) and the indicating chemical with a fresh supply. Turn on the test lamp, adjust the air knob until the light beam is centered on the engraved line in the middle of the scale. Turn off the test lamp. Repeat the procedure for the reference gas adjustment as a recheck of the upper scale limit calibration. Only a slight readjustment of the knob marked reference gas should be necessary.

7. After the analyzer has been properly calibrated, it is ready to be used for oxygen analysis. The range switch should now be in the 90-100 percent position, since the reference gas procedure has been repeated. The sample gas is passed through the instrument in a continuous flow at the rate of 200 cc. (cubic centimeter) per minute for a period of 2 minutes, observing the rate of flow carefully. Turn on the test lamp. Rotate the duodial until the light beam centers on the reference point. Turn off the lamp, and read the duodial. If the reading is below 99.50 percent, the oxygen is unfit for use in aircraft.

Whenever the power has been turned off, and the instrument has had a chance to cool, it must be recalibrated before reuse. Figure 3-10 is a diagrammatic view of the gas sampling system.

It is difficult to make fine adjustments with an ordinary pressure reading regulator. In view of this and the corresponding necessity for the application of very low flow

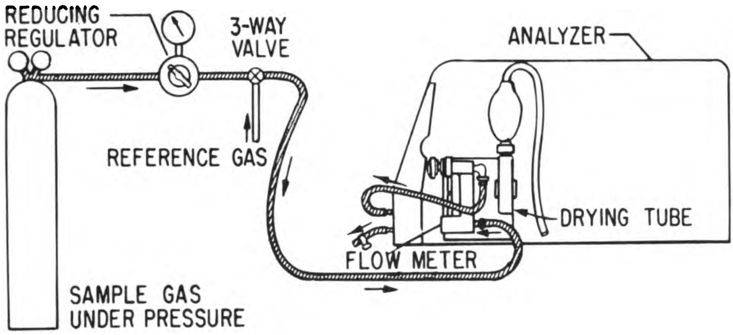


Figure 3-10.—Gas sampling system. NOTE: The arrangement from the instrument side of the 3-way valve to the source of supply can be modified as seen fit. The diagram is used primarily to convey an idea—not an inflexible physical layout.

rates in the sampling system, a special type regulator should be used. For this purpose, investigate the smooth operating medical types that can be adjusted with fingertip ease and accuracy. In selecting one of these expensive units, determine the limit of its capacity, keeping in mind its adaptability in relation to its use in the gas sampling system.

MAINTENANCE.—Thorough inspections are conducted at specified intervals to determine the condition and serviceability of the analyzer. Preventive maintenance procedures including cleaning, tightening, calibration, and testing are performed at the specified intervals of calendar or operating times. A permanent record of inspections, calibrations, and overhaul of the instrument should be kept. Naturally, only qualified personnel should conduct the procedures.

Inspections and maintenance required daily are those to be performed prior to use of the analyzer during any day of operation. Inspection times indicated in hours are the approximate instrument operating times between inspections. These times are expected to vary with operations.

Clean the lens and windows of the optical system with lens tissue; moisten with water if necessary. Clean the parts of the analyzer chassis with an approved cleaning solvent. Use the solvent sparingly and apply with a clean lint-free cloth or soft brush. Dry parts thoroughly. To remove dust from inaccessible places, use dry compressed air at a maximum of 30 p.s.i. pressure. There are no lubrication problems.

General inspection and maintenance procedures are outlined in table 3-1.

Table 3-1.—Inspection and maintenance procedures.

Procedure	Time
Check operation of analyzer lamp	Daily
Check operation of pilot light	Daily
Check movement of duodial and calibration setting knobs	Daily
Clean exterior of front panel window	Daily
Check condition of drying agent in drying tube, replace if pink	Daily
Check operation of switches	Daily
Clean lens and windows of optical system with lens tissue	Weekly
Clean interior of analyzer	Monthly
Check all wiring connections at terminal strips for tightness of terminal screws	Monthly
Inspect soldered wire connections for looseness	Monthly
Check tightness of all attaching screws, bolts, etc.	Monthly
Inspect condition of rubber shock mounts	Monthly
Inspect all parts of analyzer for evidence of corrosion	Monthly
Check tightness of all tubes in sockets . . .	Monthly
Remove, test and replace as required, all tubes in rectifier assembly	100 hours
Insert test thermometer through hole in right rear corner of insulated suspension unit housing to check temperature of suspension housing. (Refer to NavAer 17-15BC-502.)	100 hours
Check transformer for excessive heating	100 hours
Remove insulated suspension unit housing and check security of wire connections and sample inlet tubes.	200 hours

Information relative to balancing portions of the analyzer circuits, barometric and moisture corrections, mathematical formulas involving the use of the duodial, troubleshooting, and other subjects can be found in the *Handbook of Operation and Service for the Oxygen Analyzer.*

HALIDE DETECTION

While knowledge of the percentage of oxygen in a volume of gas is a good indication of its purity, it is not entirely reliable. Oxygen itself can never be anything else but oxygen, and as such it is pure; however, it can become contaminated. Unfortunately, this contamination is not detectable through the use of the oxygen analyzer. Since this is true, some device other than the analyzer which indicates the percentage of oxygen in a gaseous mixture must be used to detect the presence of halides.

A halide is a binary compound containing a halogen (chlorine, bromine, iodine or fluorine.) Binary means that chemically it is composed of two elements, of an element and a radical that acts as an element, or of two radicals. The halide of primary interest to a Parachute Rigger is a chloride.

Contamination takes place when oxygen comes in contact with chlorinated hydrocarbons. The practice of using carbon tetrachloride to clean parts of a system will later contaminate oxygen gas passing through it. The fact that carbon tetrachloride dries very rapidly and seemingly vanishes from the scene is not be trusted. The fluid residue and gas fumes created in cleaning permeate the surfaces of components; therefore, it is an ineffectual gesture to attempt wiping it away with a cloth. One must be extremely careful not to use anything but approved solvents or cleaning agents around oxygen equipment. The contamination of oxygen is dangerous—from its explosive supporting nature to its purity requirements for human consumption.

Testing Oxygen

Since the purity and the water vapor content of aviator's breathing oxygen is so important to its being used successfully at high altitudes, it must be subjected to on-the-spot periodic ground tests. Impure oxygen is dangerous at any altitude, but its water vapor content (a reasonable percentage) is not. Its water vapor content only becomes dangerous when the temperature is low enough to freeze the droplets in an oxygen system. Past experience has proven that it is impossible to conduct too many tests in determining that aviator's breathing oxygen is safe for use.

CHLORINATED HYDROCARBON CONTAMINATION.—Aviator's breathing oxygen storage cylinders, regardless of source, and aircraft oxygen cylinders are tested for chlorinated hydrocarbon contamination prior to their release for breathing purposes in aircraft. After a satisfactory completion of the test, a distinguishing tag or decal is applied to each cylinder tested, giving the date of the test, place, name of the individual conducting it, and a statement that the cylinder tested does not contain any chlorinated hydrocarbons as evidenced by no change in the color of the testing flame.

This test is performed with a halide detector, one type of which is illustarted in figure 3-11. Another type, designed to burn methyl alcohol and resembling the appearance of a flashlight, may also be used.

The normal uncontaminated flame color of the halide detector which uses methyl alcohol is colorless or possibly a very faint blue. The presence of a very slight trace of chlorinated hydrocarbon impurities in the oxygen causes this flame color to become pale green, and as the proportion of impurities increases in the oxygen a bluish-green colored flame results.

The normal uncontaminated flame color of the halide detector which uses acetylene is blue. The presence of a very slight trace of chlorinated hydrocarbon impurities in the oxygen causes the color of the flame to become pale green, and as the proportion of impurities increases, the flame becomes a more intense green. A large proportion of such impurities in the oxygen results in an intense violet color.

Any chlorinated hydrocarbon contamination, as evidenced by the color of the flame of the halide detectors, is cause for rejection of oxygen cylinders containing this contaminated oxygen. CONTAMINATED OXYGEN SHALL

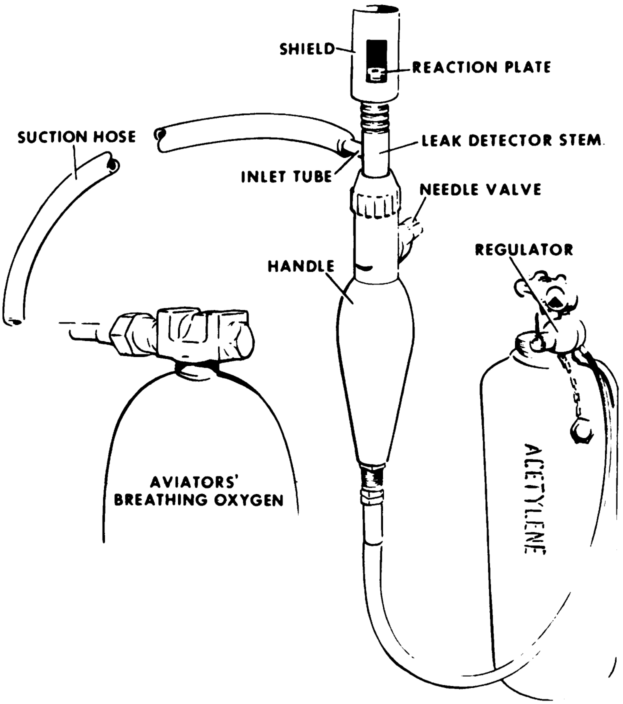


Figure 3-11.—Prest-O-Lite Halide Leak Detector, acetylene and test gas.

NOT BE USED. Rejected cylinders are appropriately tagged and returned to supply through normal channels for overhaul prior to their being recharged and retested, submitting a report to BuAer regarding circumstances of test.

A General Electric Company Type H Leak Detector Tester may be used in lieu of the halide detectors. However, the halide detectors are preferred. Each oxygen cylinder that successfully passes the General Electric Leak Detector Tester test must be tagged. This tag shall give the identity of the activity performing the test, the date of the test, and a statement that the contents of the tested cylinders do not contain chlorinated hydrocarbons in excess of fifty parts per million. Report all instances of chlorinated hydrocarbon contamination of oxygen cylinders to the Bureau of Aeronautics.

Untagged aircraft oxygen cylinders installed in aircraft and any untagged aircraft oxygen cylinders received from supply departments must be tested and tagged. Repetition of this test on previously tested and tagged aircraft oxygen cylinders is not required in the field provided recharging is always conducted from tested and tagged aviator's breathing oxygen storage cylinders.

Test tags are removed from aircraft oxygen cylinders and aviator's breathing oxygen storage cylinders until the need for retesting arises, at which time the old tag is replaced with an appropriate new one. This new tag should give all the necessary identifying information relative to the place, date, individual making the test, and the statement that the particular cylinder does not contain chlorinated hydrocarbons as evidenced by the type of instrument used. An example is as follows:

Type of test.	Chlorinated hydrocarbon
Place	NAS, Memphis, Tenn., Operations Department
Date.	11 May 1957
Tested by	John W. Smith, PR1
Result.	This cylinder was halide tested using an approved acetylene type tester on the date listed above. No trace of chlorinated hydrocarbons could be identified, as the blue flame characteristic of this testing device did not change color.

All cylinders are retested when the test tag is lost or permanently removed for any reason. All oxygen cylinders are retested when contamination of the oxygen system occurs or is suspected.

All aircraft oxygen cylinders are retested when the aircraft in which they are installed are overhauled.

Inspect all aircraft oxygen cylinders during aircraft acceptance checks for compliance with the last statement.

Water vapor tests and other purity tests may be conducted by experienced Parachute Riggers after they have attended and successfully graduated from the appropriate school.

SAFETY PRECAUTIONS

Spontaneous combustion is an ever-present hazard when handling oxygen. If a material that is readily oxidized is brought in contact with a heavy concentration of oxygen (oxygen under pressure in a confined space) heat will be generated by the rapid oxidation of the material. If this heat cannot be dissipated, the temperature soon builds up to the burning point of the material and it bursts into flame. With oxygen and an easily oxidized substance, once the burning point is reacted, the fire will be violent and difficult to extinguish. For this reason, stress is continually placed on the importance of extreme care in handling oxygen.

The dangers in handling oxygen have been pointed out in the Navy Training Course *Parachute Rigger 3 & 2*. In addition to observing these safety precautions yourself, you must be constantly on the alert to point out possible dangers to the less experienced men whose work you are directing. An important phase of leadership as a petty officer is leadership in safety.

QUIZ

1. The specifications for aviator's breathing oxygen include water vapor content of
   a. 2% per volume
   b. 0.5% of the known cylinder pressure
   c. 0.02 mg/liter
   d. none of the above

2. The purity of oxygen will permit a miscellaneous gas concentration of no more than what percent of the total cylinder volume?
   a. 5.0%
   b. 0.05%
   c. 0.005%
   d. 0.5%

3. The detector part of the Amnico-Weaver Vapor Indicator is
   a. dependent upon electrolyte to complete the electric circuit
   b. used with water for circuit compensation
   c. not dependent upon any medium for operation
   d. not part of the electrical circuit

4. The microammeter on the Amnico-Weaver Water Vapor Indicator
   a. should be used with shorting wires connected
   b. can be burnt out by malalignment of meter and adjuster
   c. is not dependent upon the detector for operation
   d. is only operable in combination with the detector

5. On the Amnico-Weaver Water Vapor Indicator there are
   a. 2 valves
   b. 4 valves
   c. 6 valves
   d. no valves

6. To adjust the saturated gas flow to the detector tip use the
   a. A valve
   b. B valve
   c. C valve
   d. D valve

7. The test gas pressure gage on the Amnico-Weaver Water Vapor Indicator has a range of
   a. 0-60 p.s.i.
   b. 0-300 p.s.i.
   c. 0-1,800 p.s.i.
   d. 0-3,000 p.s.i.

8. The Amnico-Weaver Water Vapor Indicator makes use of what quality of the electrolytic solution?
   a. Anhydrous
   b. Hygroscopic
   c. Viscosity
   d. Solubility

9. To fill the saturator on the Amnico-Weaver Water Vapor Indicator
   a. remove saturation gas pressure reducer
   b. loosen the detector and test gas gage line
   c. loosen test gas gage line
   d. detach two lines into top of saturator

10. The saturated gas will flow through the Amnico-Weaver Water Vapor Indicator across the detector tip at a pressure
    a. slightly greater than atmospheric pressure
    b. of 10 p.s.i. ±1/2 p.s.i.
    c. of 700 p.s.i. to 1,000 p.s.i.
    d. up to and including 1,800 p.s.i. at 70° F.

11. Using the Amnico-Weaver Water Vapor Indicator makes it necessary also to use the calculator. What setting of the Amnico-Weaver Water Vapor Indicator is not used on the calculator?
    a. Altitude (correction) setting
    b. Temperature correction
    c. Balance point
    d. None of the above

12. The valves of the Amnico-Weaver Water Vapor Indicator that are used together are the
    a. A & B
    b. A & C
    c. A & D
    d. B & C

13. The detector tip of the Amnico-Weaver Water Vapor Indicator
    a. is constructed of brass
    b. is constructed of bronze
    c. can be ground down for better operation
    d. should not be ground because of the glass insulator in the tip

14. The Beckman Analyzer range switch will
    a. give test gas purity percentage
    b. give 20%-100%, 90%-100% setting
    c. adjust air setting
    d. adjust reference gas setting

15. The model E-2 Beckman Analyzer is specifically designed to analyze mixtures of
    a. air-oxygen ratio
    b. air purity
    c. type I oxygen gas
    d. any exhaust gases for oxygen content

16. The warmup period for the E-2 Beckman Analyzer is
    a. 15 minutes
    b. 30 minutes
    c. 2 hours
    d. until neon light operates

17. To read the purity percentage it is necessary to adjust
    a. reference gas potentiometer
    b. test gas gage
    c. duodial with dial hairline
    d. read direct from scale on glass dial

18. Before testing unknown gas for purity on the E-2 Beckman Analyzer there are_______gas(es) passed through the machine to calibrate it
    a. 1
    b. 3
    c. 4
    d. no
19. Part of the E-2 Beckman Analyzer accessories consists of
    a. a flowrator
    b. a pipette
    c. an acetylene cylinder
    d. extra operational radio tubes
20. The test chamber of the E-2 Beckman Analyzer will withstand
    a. 1,800 p.s.i. pressure
    b. any pressure over 300 p.s.i.
    c. a flow of approximately 200 cc/min.
    d. 500 p.s.i. pressure
21. The halide detector flame turning purple indicates
    a. high chlorinated hydrocarbon content
    b. acetylene in the tested cylinder
    c. gas other than chlorinated hydrocarbon present
    d. hydrogen gas present in oxygen
22. A halide detector may burn
    a. methyl alcohol or acetylene
    b. compressed water pumped hydrogen
    c. white gas
    d. sterno
23. Aircraft cylinders installed in the aircraft should be tested with a halide detector each
    a. 30 hours
    b. 60 hours
    c. 120 hours
    d. overhaul period
24. Aviator's breathing oxygen is
    a. an explosive gas
    b. not able to burn by itself
    c. only a stable element as a gas
    d. impossible to liquefy
25. Chlorinated hydrocarbon contamination is easily detected by the
    a. E-2 Beckman Analyzer
    b. Amnico-Weaver Water Vapor Indicator
    c. Prest-O-Lite Halide Leak Detector
    d. lime water precipitation process

CHAPTER 4

REGULATOR TEST STANDS

OT-122C (ARO) TEST STAND

The OT-122C regulator test stand is designed to test all demand type oxygen regulators, including pressure breathing type, for flow capacities, oxygen concentrations, and pressure characteristics at various test altitudes. The complete test stand is composed of an input flowmeter, output flowmeter, suction manometer, pressure-suction gage, altimeter with buzzer, pressure chamber, three control valves, and connecting tubing and piping. Figure 4-1 is a front view drawing of the complete assembly. Figure 4-2 is a rear view drawing, showing the relationship between the output flowmeter, canister, and air-oxygen flow.

Principles of Operation

The output flowmeter measures the OUTPUT DELIVERY of the regulator, which is mounted in the pressure chamber. The input flowmeter measures the FLOW OF AIR being drawn into the pressure chamber. The input flow of air is the same as the output flow of air-oxygen through the regulator when the pressure in the chamber in constant. The flowmeters are of the linear resistance type, in which the pressure drop across a canister packed with glass wool is the measure of the flow. The canisters have a range of 0-150 l.p.m. with a pressure drop of 10 inches of water pressure across the canister. For testing

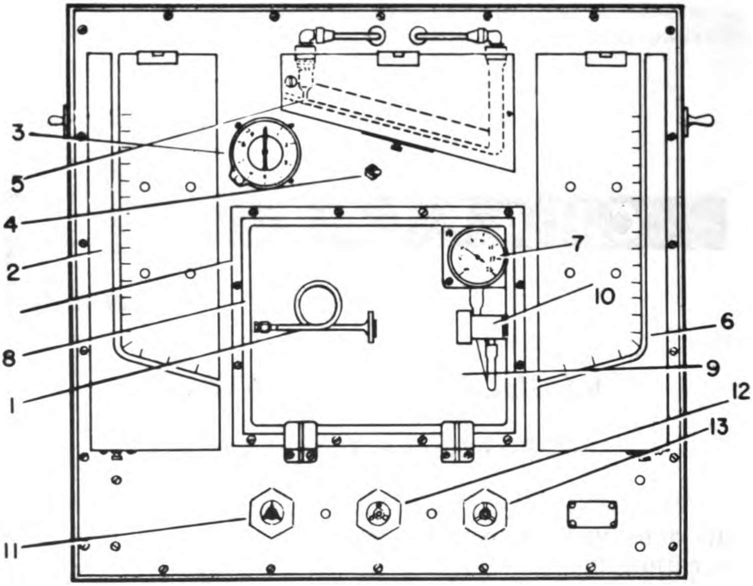


Figure 4-1.—Front view drawing of OT-122C test stand.

1. Oxygen pressure inlet.
2. Output flowmeter.
3. Altimeter.
4. Buzzer switch.
5. Suction manometer.
6. Input flowmeter.
7. Pressure-suction gage.
8. Chamber cover plate.
9. Pressure chamber.
10. Outlet connection.
11. Outlet valve.
12. Bypass valve.
13. Inlet valve.

purposes, 150 l.p.m. comprises the full scale; however, each flowmeter is graduated to 160 l.p.m.

The inlet and outlet valves (fig. 4-2) control the flow of air into the chamber and the flow of air-oxygen from the regulator and chamber. By manipulating these valves, the rate of flow can be increased or decreased, depending on the effect desired. Controlling the rate of flow through the outlet valve, evacuates the air in the chamber through the opened air valve of the oxygen regulator. Obviously, before altitude levels can be simulated, the glass cover must be placed in position over the chamber. The gas flow moving from the chamber and regulator through pipe (2) enters the top of the output canister (3). Attached near the top (pressure side) of the output canister is a tube (4), which leads to the bottom of the output flowmeter.

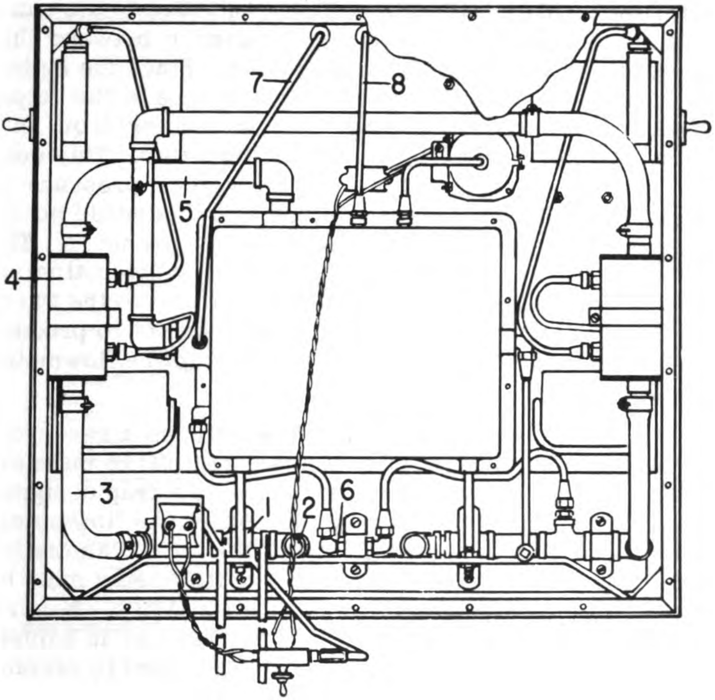


Figure 4-2.—Rear view drawing of OT-122C test stand.

1. Outlet valve.
2. Regulator output pipe.
3. Output flowmeter canister.
4. Tubing leading from pressure buildup side of output canister to bottom of output flowmeter.
5. Tubing leading from pressure drop side of output canister to top of output flowmeter.
6. Pipe leading to vacuum pump.

Another tube (5), attached to the canister near the bottom (pressure drop side), leads to the top of the output flowmeter.

After passing through the output canister, the flow continues on through pipe (6) until it enters the vacuum and is passed on to the atmosphere. The glass wool packing acts as an obstruction to the flow which is being drawn through the system constantly. The amount of the output flow is controlled by setting of the outlet valve.

The flow is ALWAYS greater at the entrance of the canister than at the exit, and the difference between this pressure varies with the rate of flow. Since the higher pressure area is in the top part or entrance of the output canister, the corresponding tube (4) leading from this point is fitted to the bottom of the flowmeter. This connection makes it possible for the higher pressure to actuate the fluid in the flowmeter, but this would not be possible if there was not a difference in pressure. The lower pressure (pressure drop) tapped at the bottom or exit of the output canister, and led in a tube to the top of the flowmeter, works with the higher pressure to produce a smooth even rise and fall of the fluid in the flowmeter tube.

At the bottom of the output flowmeter is a reservoir which contains enough fluid (Meriam red oil) to maintain a zero setting on the scale. At the top is a trap designed to catch the fluid surged beyond the limit of the flowmeter, thus eliminating the possibilities of the oil contaminating the glass wool packed canister. The flowmeter must be kept level in order to give an accurate reading. A spirit level is located at the top of the flowmeter and an adjusting screw at the bottom. These are provided to accomplish the alignment.

As shown in figure 4-3, the inlet valve (1) controls the rate of flow of air into the chamber when it is manipulated in conjunction with the outlet valve. When the outlet valve is open, the chamber is being evacuated. Opening the inlet valve while the outlet valve is also open causes the air outside the chamber (ambient air) to be drawn in at the open exposed end of pipe (2). Passing through the inlet valve, the air continues traveling in pipe (3) where it is directed into the bottom of the input canister (4), serving the input flowmeter. Again, the same condition is set up in this area as was described previously. A pressure differential is established between the bottom (pressure buildup) and the top (pressure drop) of the input canister. The same rule applies on the input canister, the pressure buildup is created where the flow enters the canister, regardless of input or output. Air enters the chamber through pipe (5), leading from the top (pressure drop) of the canister.

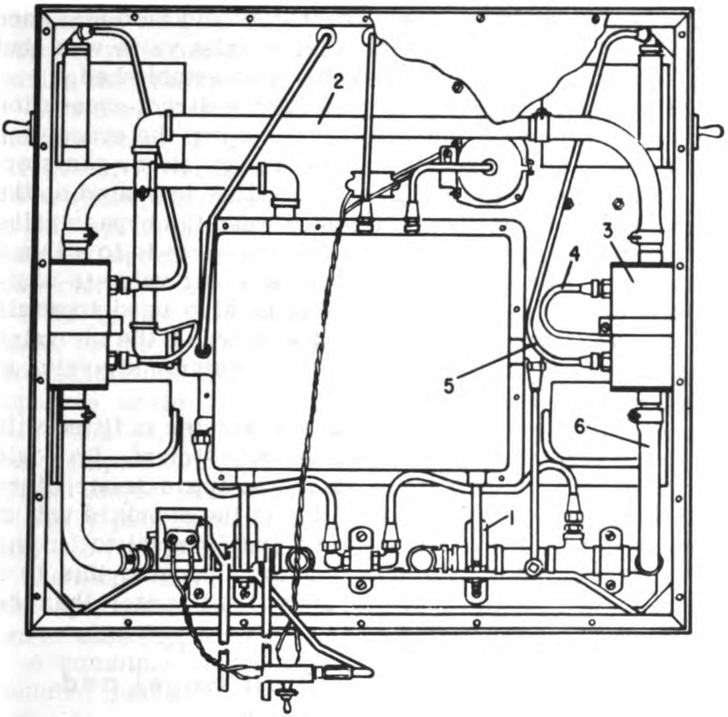


Figure 4-3.–Rear view drawing of OT-122C test stand, showing the relationship between the input flowmeter, canister, and flow of air.

1. **Inlet valve.**
2. **Air intake pipe.**
3. **Pipe leading into the bottom of the input canister.**
4. **Input flowmeter canister.**
5. **Pipe leading into the chamber.**
6. **Bypass valve.**
7. **Tube from regulator outlet to the suction side of the manometer.**
8. **Tube from the pressure side of the manometer to the chamber.**

With the outlet valve open, the suction created by the vacuum pump draws the air into and through the oxygen regulator. At any time air is admitted into the evacuated chamber, it will reduce the simulated altitude, provided the volume of the vacuum flow (output) is not greater than the volume of airflow (input) into the top of the chamber. It would then follow, to hold a steady altitude, that the input and output flows must be balanced. The test stand operator should practice balancing the output and input flows until the altimeter can be stabilized quickly and smoothly. The operator should also be aware of the results if either the outlet or inlet valve was shut off suddenly after a balanced flow was established.

The bypass valve (6) is used for the direct evacuation of the chamber. When this valve is open, the evacuation is not through the regulator nor through either canister; consequently, there will be no reading indicated on the flowmeters for the flow established when the bypass valve is used. The purpose of the bypass valve is to attain a simulated altitude when the regulator air valve is positioned at 100 percent oxygen. It is also used to attain higher altitudes than the altitude at which the air valve aneroid closes off the air when the regulator air valve is positioned at normal oxygen.

Like its counterpart, the input flowmeter is fitted with a reservoir, oil trap, and leveling adjustment. Its scale is graduated to indicate readings in approximate liters per minute. Remember, the liter is the standard unit of capacity (in the metric system) and is equal to 1 cubic decimeter or 1.0567 liquid quarts. Changing this to a fraction, a liter is approximately 1/18 larger than the U. S. quart.

Suction Manometer (Draft Gage) and Pressure-Suction Gage

The suction manometer is calibrated from +0.60 to -1.60 inches of water and measures the suction required to obtain the required flows from the regulator at various altitudes. Figure 4-1 does not show the suction manometer cutoff valves, since they are not needed to illustrate the physical connections of the manometer with the system. In practice, however, the valves are installed at the points where the tubing goes to the manometer. Located in this position and turned off, the valves prevent overloading when the suction manometer is not needed, as is the case in some tests.

Tubing is connected at the regulator outlet and runs to the suction side of the manometer. The pressure side of the manometer is tapped by tubing leading to the top of the chamber. This second connection completes the arrangement and makes it possible to obtain readings on the manometer. The scale can be readjusted to zero, coinciding with the level of the fluid in the tube by loosening a retaining thumbscrew and moving the plate containing the graduations.

The suction manometer is scaled and calibrated on a definite slope. The slope is employed in order to spread the scale. Where the use of mercury for measuring low flows would prove impractical, so would it be impractical, to attempt measuring a vertical column of oil where the range of operation is restricted. While the scale of this manometer is calibrated over a distance of approximately 8-9/32 inches, the actual vertical rise (from -1.60 to +0.60) of the fluid in the tube is only 2.20 inches. So, by sloping the tube and scale, 110 easily distinguishable and separate scale graduations may be made between the -1.60 and +0.60 inches of water. Figure 4-4 illustrates this comparison. A less acute angle on the slope will spread the scale even more.

For a pressure of one atmosphere, a column of mercury will rise 30 inches, measured vertically, regardless of the slope of the tube in which it is contained. For the same pressure and using water, we would need a much longer tube (approximately 33 feet).

A combination pressure-suction gage (fig. 4-1) is mounted inside the chamber. It is used to measure pressures when testing automatic positive pressure regulators or when testing for leaks on the diluter demand regulators. The pressure-suction gage is calibrated from 25 inches of pressure to 10 inches of suction.

The remaining components of the test stand, such as the chamber, buzzer, altimeter, case, etc., need not be discussed in detail as the purpose of each of these

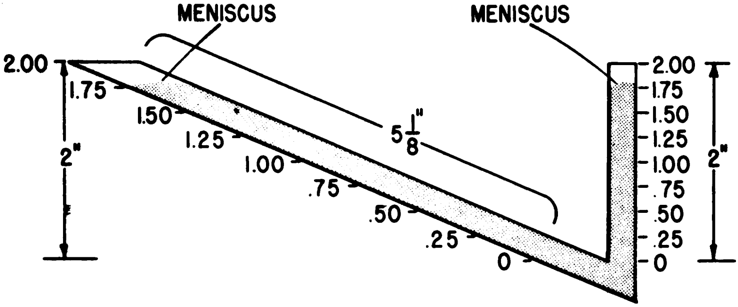


Figure 4-4.—Comparison of vertical and sloping scales.

elements is obvious. However, a few words should be mentioned about the connecting tubing. The tubing used to connect the manometers to their source of measurement can be made of rubber, plastic, or metal. Whether or not they disengage easily, such as at the oil well or reservoir points, is of secondary importance. The primary factor is, as always, leaktightness. The simplest way to connect components is to use rubber or synthetic tubing. The most popular size used is 1/4 inch. When the tube diameter is too small, a smooth flow through the tube is prevented. Figure 4-5 is a schematic diagram of the flows through the test stand.

Modified Test Stand Pressure-Suction Manometer

Since the suction manometer (draft gage) supplied with the OT-122C test stand has such a limited scale, and the pressure-suction gage located inside the chamber is so sensitive (becoming inaccurate through inadvertent abuse), it is necessary to extend the scale as shown in figure 4-6. Increasing the range of the modified pressure-suction manometer eliminates the need for the pressure-suction gage.

The old scale was sloped throughout its range because very low flows cannot be measured accurately on a limited vertical scale. The new extended scale is also sloped, but on a slightly more acute angle than the older one. At both ends of the slope the scale continues in a vertical plane. The pressure side of the zero is extended to approximately 18 inches of water. Since the pressure-suction extended manometer is locally manufactured, the range is not confined to a set scale, although 18 inches of water pressure is sufficient for all pressure breathing tests. The same rule applies to the suction side of the zero, but it is normally scaled in the neighborhood of 10 inches of water suction.

The reservoir attached to the back of the mounting board is filled with water until the fluid rises in the tube to the zero mark. To aid in reading, a few drops of cake coloring should be added to the water.

In modifying the test stand, the old suction manometer and connecting tubing are removed and the new extended

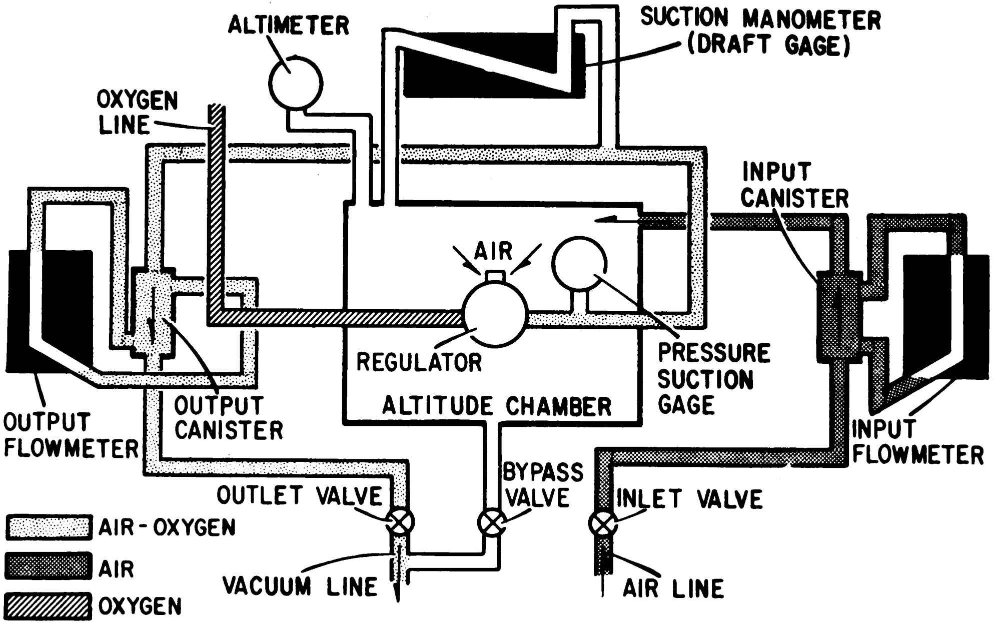


Figure 4-5.—Schematic diagram of flow through test stand.

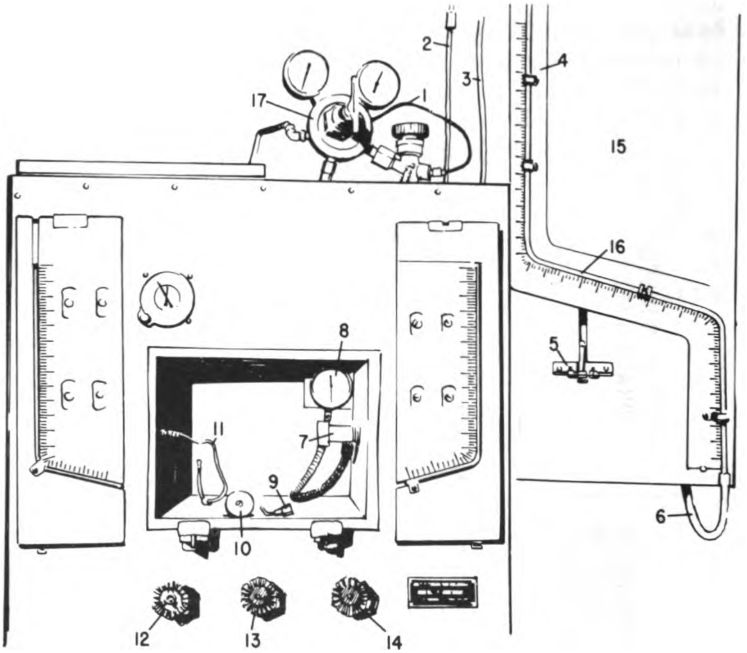


Figure 4-6.—Front view of OT-122C test stand showing modified extended scale pressure-suction manometer.

1. Oxygen line from source of oxygen to the pressure reducer.
2. Line connected to bottom of pressure-suction manometer from regulator.
3. Line connected to top of pressure-suction manometer from top of chamber.
4. Extended scale.
5. Zero adjustment (necessary to correct for changes in atmospheric pressure and/or loss of fluid).
6. Continuation of line (2) leading from the reservoir to bottom of manometer.
7. Chamber outlet (regulator outlet connected here).
8. Pressure-suction gage. The pressure-suction gage is disconnected or removed and the line plugged when test stand is modified with the extended manometer.
9. Plug for oxygen inlet when testing test stand for leakage and calibration.
10. Orifice (supplied with the test stand for checking calibration of flowmeters).
11. Oxygen inlet line (connected to regulator inlet).
12. Outlet valve.
13. Bypass valve.
14. Inlet valve.
15. Vertical mounting board.
16. Tubing (1/4-inch laboratory glass tubing).
17. Pressure reducer and oxygen supply valve (mounted to top of test stand case).

scale is attached to a mounting board which is fastened to the side of the case. (See figs. 4-6 and 4-7.) The oxygen supply line (1) connects to a pressure reducer which, in turn, is connected to the oxygen test stand chamber inlet.

With a regulator in the chamber and the outlet valve open, the output flow creates a suction; therefore, there is more pressure in the chamber than in the regulator. This suction is transmitted to line (2), which is connected to the bottom of the pressure-suction manometer. Action in this direction draws the fluid in the manometer tube down. Conversely, if there were more pressure in the regulator (as is the case when actuating the safety pressure), the pressure would be transmitted to the same line. Consequently, the fluid in the manometer tube would be pushed up, due to more pressure in the regulator than in the chamber. This action, then, is a measurement of the difference in pressure (differential pressure) between the air-oxygen mixture inside the regulator and the air outside the regulator which is confined in the chamber. Line (3), as shown in figure 4-7, is attached from the test stand chamber to the top of the manometer tube. A schematic diagram of the flow through the modified test stand is shown in figure 4-8.

Another type modification is shown in figures 4-9 and 4-10. This unit is manufactured by the Meriam Company of Cleveland, Ohio. It has a scale ranging from 8 inches of water suction to 35 inches of water pressure. At the back of the instrument, located at the zero level, is a well containing the fluid. The lower connection is made from the well to the regulator outlet projection and the upper line connects from the top of the pressure-suction manometer to the top of the test stand chamber.

Inspection and Maintenance

The test stand is checked daily for air leakage. Calibration of flowmeters must be checked daily by means of a standard orifice supplied with the test stand. If flowmeter readings do not check with chart readings (allowable tolerance, 4 percent), recalibrate the test stand or replace the canisters.

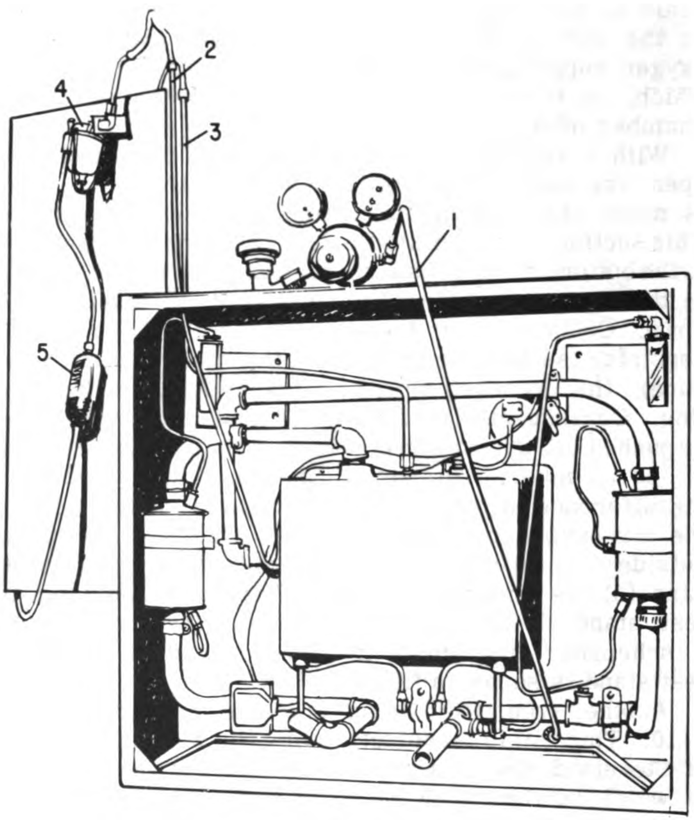


Figure 4-7.—Rear view of OT-122C test stand, showing modifiod extended scale pressure-suction manometer.

1. Oxygen line from pressure reducer to the chamber inlet.
2. Pressure-suction line from outlet of chamber to the bottom of the pressure-suction manometer.
3. Line connecting top of test stand chamber to the top of the pressure-suction manometer.
4. Overflow trap. When fluid is forced up the manometer tube carelessly, it is caught in the trap. When the fluid is drawn down due to excessive suction it is caught in the reservoir bulb.
5. Reservoir bulb, fastened to a movable component. The reservoir can be moved up or down with the zero adjustment screw. This action changes the level of the fluid corresponding to the zero adjustment.

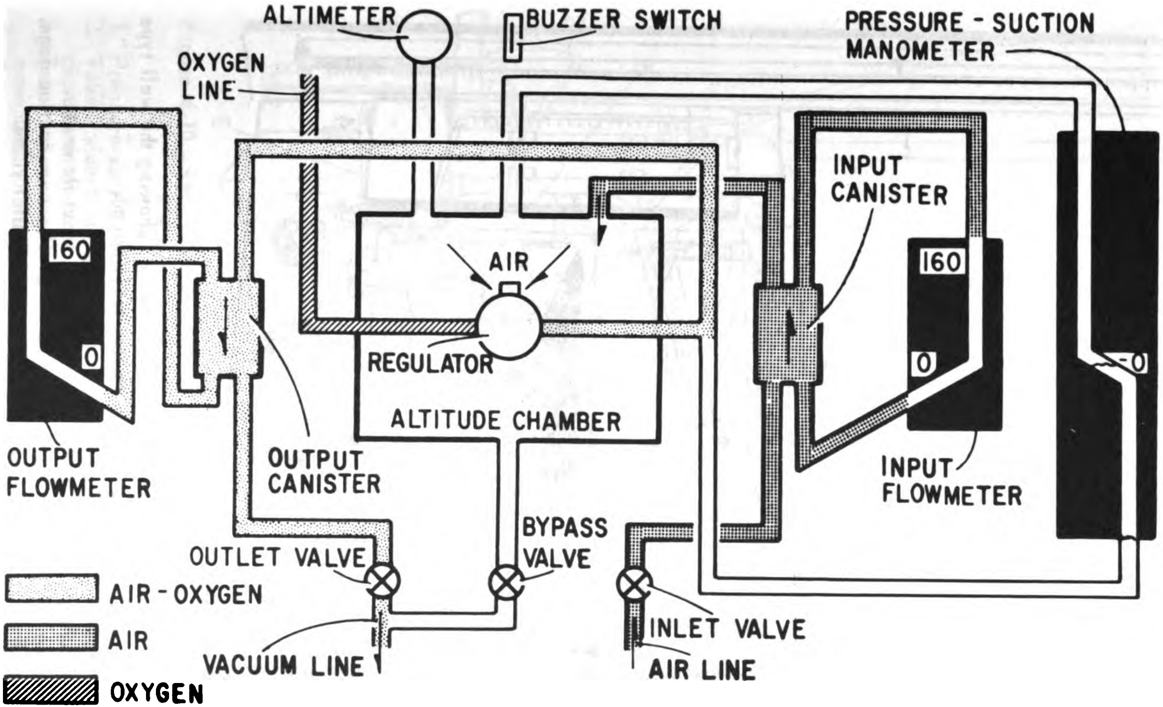


Figure 4-8.—Schematic flow of OT-122C test stand with modified pressure-suction manometer.

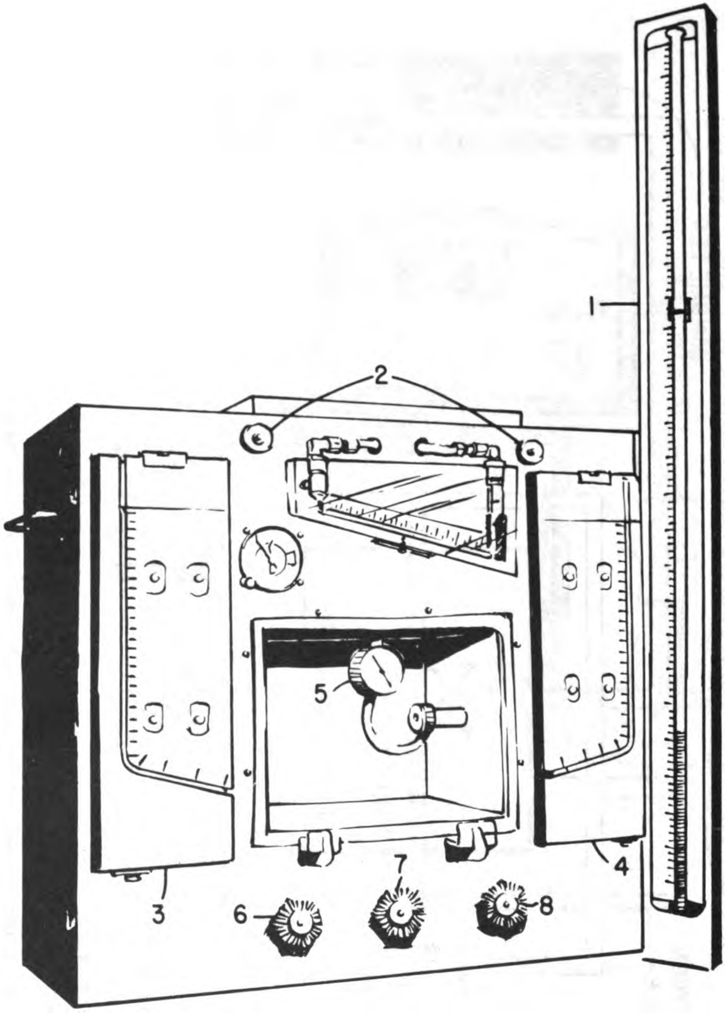


Figure 4-9.—Front view of OT-122C test stand, showing the well type pressure-suction manometer (Meriam).

1. Pressure-suction manometer (Meriam).
2. Shutoff valves for the old type suction manometer (draft gage).
3. Output flowmeter.
4. Input flowmeter.
5. Pressure-suction gage.
6. Outlet valve.
7. Bypass valve.
8. Inlet valve.

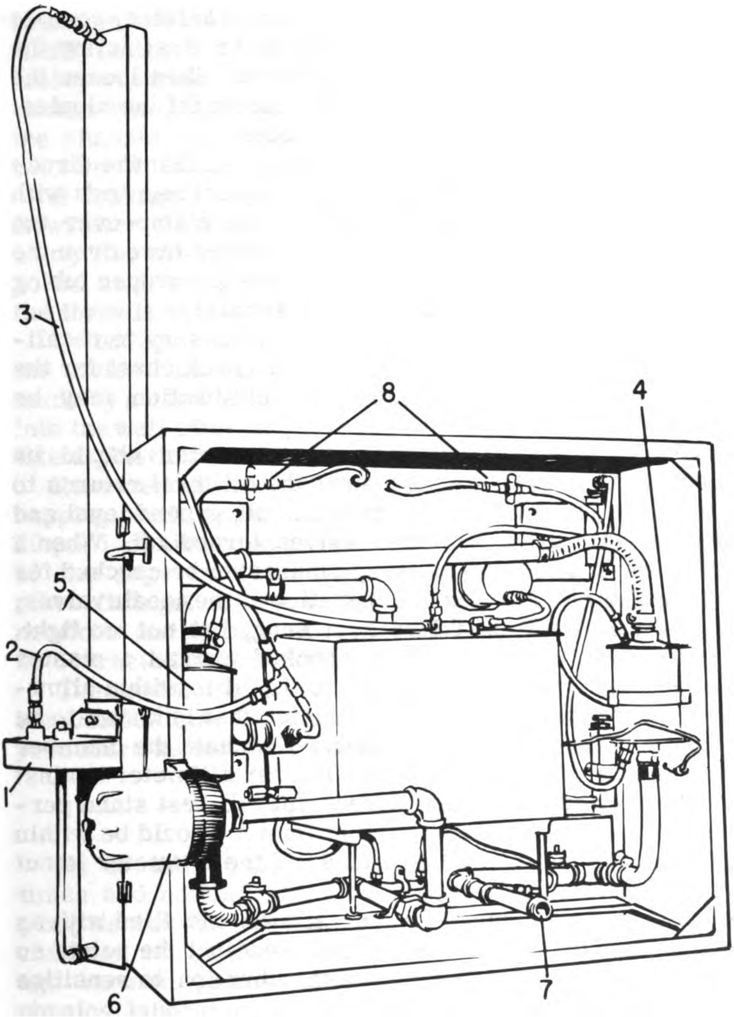


Figure 4-10.—Rear view of OT-122C test stand, showing the well type pressure-suction manometer (Meriam).

1. Pressure-suction manometer well.
2. Tube connecting the outlet of the chamber to the well.
3. Tube connecting the top of the manometer to the chamber.
4. Output canister.
5. Input canister.
6. Air intake filter.
7. Pipe leading to source of vacuum.
8. Shutoff valve on old type suction manometer (draft gage).

To replace either the input or output canister, remove the tubing leading to the canister after first noting the fittings to which the tubing is connected. Then loosen the hose clamps and slide the rubber tubing off the nipples. Remove the clamp holding the canister.

Place the new canister in position so that the direction of flow of gas through the piping corresponds with the arrow on the canister. Place the clamp over the canister body and tighten. Slide the rubber hose over the nipples and tighten hose clamps. Place the proper tubing on the canister fittings and tighten securely.

If canisters are replaced, it is necessary to recalibrate the test stand and make a new check chart for the standard orifice so that the new calibration may be checked.

The flowmeters and suction manometer should be checked at intervals to be sure the oil level returns to zero. The check should be made at both ground level and altitude with all the control valves turned off. When a pressure-suction gage is used, it must also be checked for return to zero. For smooth operation of the needle valves, the packing nuts should be kept snug, but not too tight.

The altimeter should be checked against a master altimeter semiannually to insure that it is within allowable tolerances. Place the altimeter that is known to be correct in the test stand chamber. Evacuate the chamber to test altitude and check the master altimeter against the test stand altimeter. Check for all test stand performance chart altitudes. The altimeter should be within current altimeter specifications. If the altimeter is out of calibration, replace it.

The buzzer points may be cleaned and filed with an automotive or aircraft point file. Readjust the points so that the buzzer furnishes enough vibration to sensitize the altimeter.

The control valves may be taken apart and the seating surfaces examined for abrasions or dirt. Clean any dirt or foreign matter from seating surfaces and reassemble. If there are abrasions on the valve surfaces, replace the valve if possible; otherwise, reseat the valve and reassemble.

The chamber gasket should be cleaned with a soap and water solution so that its surface is kept smooth.

Examine the chamber gasket frequently to see that it is firmly fastened to the rim of the chamber. If it is pulled loose, recement it to the chamber rim with a suitable rubber cement. With the glass cover in place, evacuate the chamber to 5,000 feet. This will hold the gasket to the rim while the cement is drying.

If leakage has developed around the input or output flowmeter fittings, they may be removed and resealed, using Rectorseal No. 15 or other approved sealing compound such as Permatex No. 3. Place the compound on the threads and screw into the flowmeter well.

If leakage has developed around the connection where the meter tubing is connected to the well, repair may be made by removing the gage oil and recementing the tubing into the well after all parts have been thoroughly cleaned. Use a plastic cement for this purpose.

Recemented connections or fittings may be checked by capping one fitting of the gage and applying not more than 10 p.s.i. of air or oxygen pressure to the tubing and wells of the gage by connecting the pressure source to the other fittings. Check with soap solution around all connections and fittings for air leakage. Any leakage must be corrected before the gage can be used.

The suction manometer and modified pressure-suction manometer may be checked for air leakage by the same procedure as for the input or output flowmeters.

VACUUM PUMPS

Up to this time, vacuum has been mentioned many times and nothing about the vacuum pump. The vacuum pump is the device that is used to draw air out of the chamber of oxygen regulator test stands. Fifty years ago vacuum pumps were used almost exclusively in physics laboratories, but today industry and many other fields of enterprise have developed hundreds of uses for the device that will pump air and other gases out of a vessel. A basic form of mechanical pump consists of a cylinder fitted with a piston (such as is found in life raft pumps). At the lower end of the cylinder are two short tubes. The fittings to which the tubes are connected are equipped with conical type valves (very similar to the type and body arrangement of the oxygen system check valves). These valves are arranged so that when the piston is drawn up, the air in the vessel, which is to be exhausted, expands into the cylinder through the inlet valve. Pushing the piston down compresses the air; and as a result, the inlet valve closes while the outlet valve opens. With each cycle (double stroke) a fraction of the air in the vessel is removed. This fraction is the ratio of the volume of the cylinder to the combined volumes of the cylinder and the vessel.

As an example, consider that the vessel has a capacity of 9 liters and the pump cylinder a capacity of 1 liter. This is a combined capacity of 10 liters. A mechanically perfect pump could remove one-tenth of the air after the first stroke, while the fraction of air remaining (nine-tenths) would expand to fill the 10 liters. With the second stroke, one-tenth more of the remaining air would be removed, leaving nine-tenths of nine-tenths of the original air in the pump. After a certain number of strokes, nine-tenths of the original air would be left. Even after the application of a mechanically perfect pump, a chamber cannot be completely evacuated; since with each stroke, only a fraction of the air is removed while the remainder expands to fill the chamber. Actually, no pump is perfect, they all leak. However, with some types, it is possible to obtain a very high degree of vacuum. When only about one-millionth of the air normally present in a chamber is left, it is almost perfect.

With a regulator test stand, such a high degree of vacuum is not necessary. To simulate 20,000 feet, at which altitude the atmospheric pressure is 6.7 p.s.i., the vacuum pump must reduce the chamber pressure 8.0 p.s.i., the difference between the sea level atmospheric pressure of 14.7 p.s.i. and 6.7 p.s.i. When we consider that the pressure must be reduced and held for each succeeding rise in altitude up to 28,000 to 32,000 (when the air valve of the regulator closes), it must also be realized that under these conditions, air is being admitted into the chamber. After the air valve has closed and the input of air is no longer necessary, it is an easier task for the vacuum pump. This is true up to a point, but if the pump does not have the capacity for reducing the pressure in the chamber low enough to simulate 50,000 feet (altitude necessary for the pressure breathing back tests), a larger capacity pump will be needed. The test stand handbooks recommend a vacuum pump with a capacity of approximately 6 standard cubic feet per minute at 35,000 feet.

Models R-15 and R-17

These vacuum pumps are manufactured by the Quincy Compressor Company of Quincy, Illinois, and are practically identical in construction. The R-15 is illustrated in figure 4-11.

INSTALLATION.—The pump should be installed in a lighted area free from excessive dust, and where there is enough room for inspection of the unit. The pump

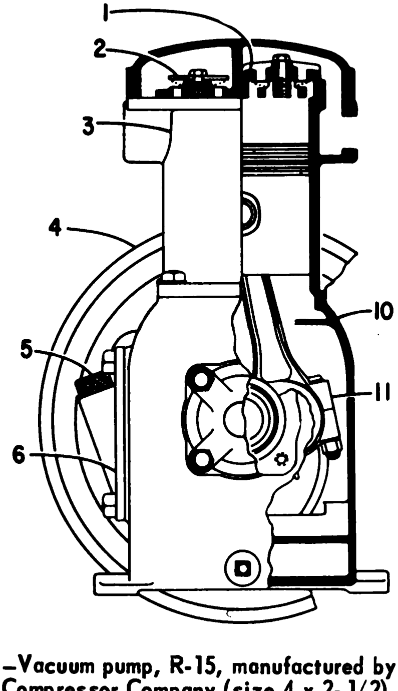


Figure 4-11.—Vacuum pump, R-15, manufactured by the Quincy Compressor Company (size 4 x 2-1/2).

1. Suction valve seat.
2. Discharge valve bumper.
3. Cylinder.
4. Pulley, 11-5/8-inch diameter.
5. Bayonet oil level gage.
6. Inspection plate.
10. Crankcase.
11. Connecting rod assembly.

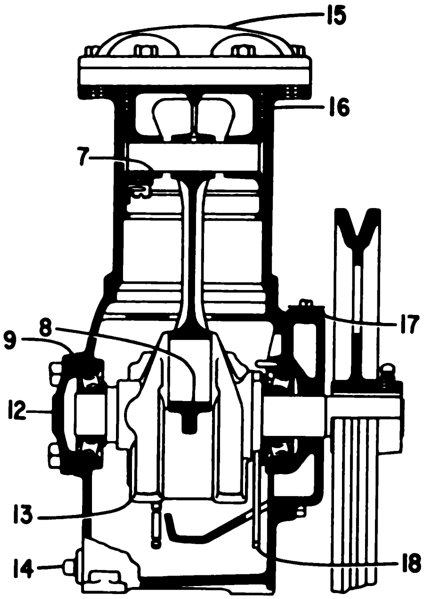


Figure 4-11.—Vacuum pump, R-15, manufactured by the Quincy Compressor Company (size 4 x 2-1/2)—Continued.

7. Piston (standard).
8. Connection rod bearing.
9. Shim for bearing adjustment (0.005 inch thick).
12. Bearing adjustment plate.
13. Crankshaft.
14. Oil drain plug.
15. Head.
16. Piston rings (Standard vacuum).
17. Breather valve.
18. Oil circulating ring.

should be bolted to a substantial level foundation, where it will not break away from the power unit. The piping between the vacuum pump and the test stand, and from the discharge opening in the pump to the atmosphere, should be equal to the full diameter of the openings in the pump. In addition, the piping should be as free from bends as possible and care should be taken to insure that the entire line is free from scale and foreign matter which might be drawn into the pump and lodge under the valves.

LUBRICATION.—Before starting the vacuum pump, fill the crankcase to the full level mark on the bayonet oil level gage. Oil should be added when the level falls to the low mark. Use a good grade of automobile engine oil. If the temperature (where the pump is located) is 32° or above, use SAE 20; below 32°, use SAE 10. Change the oil when it becomes dirty, cleaning the crankcase before refilling. The time between changes is purely problematical.

PUMP SPEED.—The minimim speed of the pump is 400 r.p.m. and the maximum speed is 940 r.p.m. The speeds at which it can be run with various size electric motors follow:

Model No. R-15 1/3 hp., 400 r.p.m. (piston displacement, 7.2 cubic feet).

Model No. R-15 1/2 hp., 525 r.p.m. (piston displacement, 9.5 cubic feet).

Model No. R-17 3/4 hp., 800 r.p.m. (piston displacement, 14.5 cubic feet).

Model No. R-17 1 hp., 940 r.p.m. (piston displacement, 17.0 cubic feet).

ELECTRIC MOTORS.—Avoid low voltage conditions. Make certain that the motor is the correct type for the available current. In most cases an electrician will be responsible for the installation; however, there are a few single tasks that can be performed by the Parachute Rigger. These would involve little more than keeping the motor clean and lubricated.

ENGINE DRIVEN PUMPS.—Instructions for the care of gasoline power units are shipped with the equipment. Read them carefully before attempting to set up or operate the assembly.

V-BELT.—When the drive is by V-belt, excessive tension is not necessary but slippage is not permitted. The driving pulleys of the motor and pump must be aligned perfectly to avoid unnecessary wear of the belt and machine bearings.

C11250 (ARO) TEST STAND

Two views of another test stand manufactured by the ARO Equipment Corporation are shown in figure 4-12. The major differences between the older model OT-122C and the new C11250 can be noticed immediately. For instance, the output and input flowmeters have been

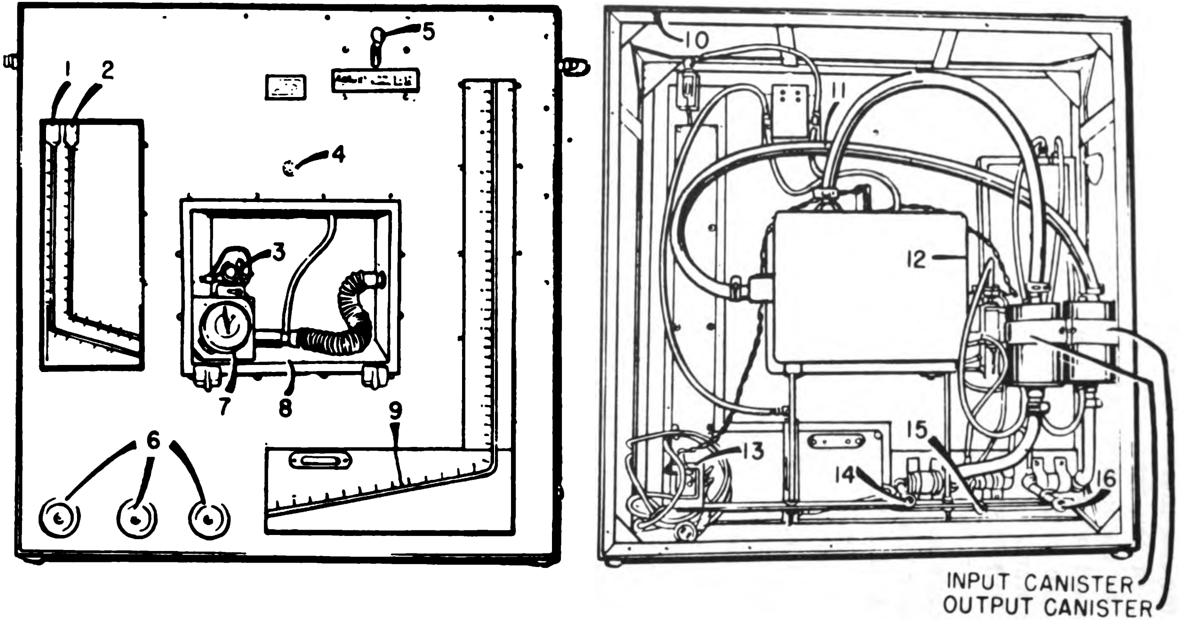


Figure 4-12.—Front and rear views of C11250 (ARO) test stand.

Nomenclature for Figure 4-12.

1. Output flowmeter.
2. Input flowmeter.
3. Buzzer.
4. Buzzer switch.
5. Emergency pressure release.
6. Control valves.
7. Altimeter.
8. Pressure chamber.
9. Pressure-suction manometer.
10. Case.
11. Rubber tubing.
12. Chamber.
13. Transformer.
14. Air control line.
15. Oxygen line.
16. Air-oxygen line.

grouped together and placed on the left side of the test stand. All reference to right or left side is made with the operator facing the front or pressure chamber side. Instead of a short-ranged suction manometer, one of greater range has been installed and located on the right side of the test stand. The pressure-suction manometer is calibrated from +20.0 to -2.0 inches of water. The altimeter is mounted in the chamber, and a more flexible regulator-connecting assembly has been adapted.

The tubing connected to the corrugated hose inside the pressure chamber leads to the bottom of the pressure-suction manometer. This serves the same purpose as the tubing leading from the outlet projection outside the chamber on the OT-122C test stand. The position of the tubing was shifted to the inside of the chamber when the corrugated hose was incorporated. For the sake of accuracy, it is important to locate the pickup tube leading to the bottom of the source of measurement as close to the actual outlet of the oxygen regulator as possible.

Instead of an additional water trap, as shown in one of the local modifications of the older OT-122C test stand, the C11250 is equipped with an emergency pressure release. Engaging the emergency pressure release (pulling it down) pinches off a tubing bridge connected between the lines leading to the top and bottom of the pressure-suction manometer. To avert actuating the fluid into the chamber and regulator, the emergency pressure release is pushed up. This allows the tubing to open, equalizing the pressure in the two lines, and fluid remains in the tube of the manometer.

Irrespective of the above changes and the relocation of the other instruments in the stand, the connections between the flowmeter canisters and the regulator in the chamber are identical to those of the older OT-122C test stand. For additional information concerning the C11250 test stand, refer to the *Handbook of Operation and Service Instructions,* NavAer 17-15BC-503.

OTS-565 (NIL) TEST STAND

Aside from appearance, the principal difference between the OTS-565 and the other types of test stands is that the OTS-565 is equipped with Vol-O-Flo elements.

The Vol-O-Flo elements are used to create the pressure drop necessary to actuate the Vol-O-Flo manometers, while the others are equipped with glass wool canisters designed for the same purpose. The OTS-565 is also different in that the complete test stand is calibrated in inches of water instead of l.p.m.

Figure 4-13 and 4-14 illustrate the front and rear views of the equipment. The top cabinet consists of an altitude chamber, piping assemblies, control valves, Vol-O-Flo manometers, Vol-O-Flo elements, pressure-suction manometer, altimeter, and pressure gages. The

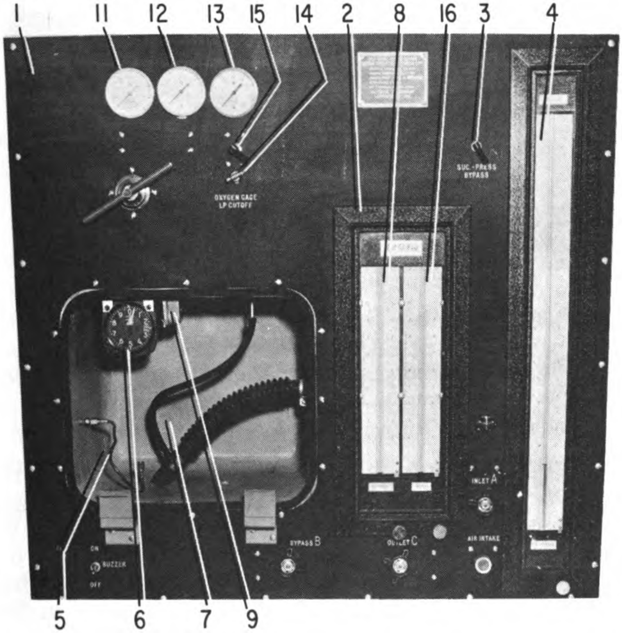


Figure 4-13.—Front view of OTS-565 (NIL) test stand.

1. Case.
2. Panel.
3. Vol-O-Flo inlet manometer.
4. Pressure-suction manometer.
5. Oxygen inlet.
6. Altimeter.
7. Altimeter chamber.
8. Vol-O-Flo outlet manometer.
9. Buzzer.
10. Oxygen pressure reducer.
11. Cylinder pressure gage.
12. Regulator pressure gage, high pressure.
13. Regulator pressure gage, low pressure.
14. Oxygen cutoff valve.
15. Relief valve (bleed valve).
16. Pressure-suction relief valve.

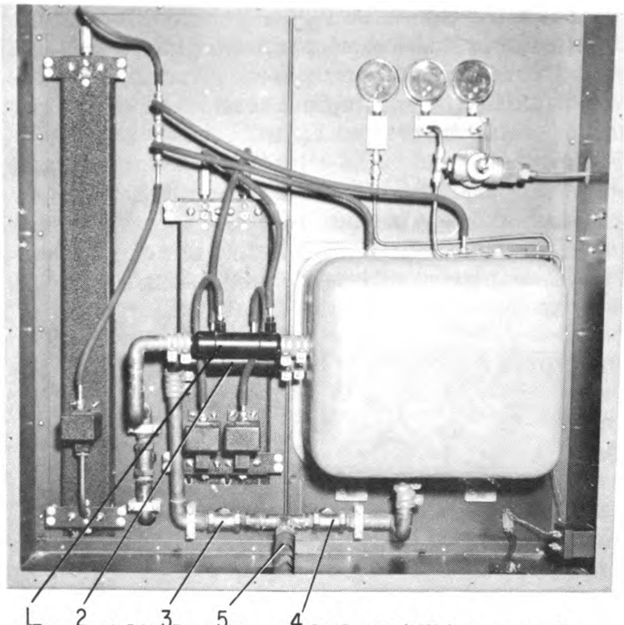


Figure 4-14.—Rear view of OTS-565 (NIL) test stand.

1. **Vol-O-Flo inlet element.**
2. **Vol-O-Flo outlet element.**
3. **Inlet piping assembly.**
4. **Outlet-bypass piping assembly.**
5. **Vacuum outlet.**

lower cabinet contains a Gast vacuum pump directly coupled to a 1 hp. motor. Figure 4-15 illustrates the assembly.

Principles of Operation

The OTS-565 (NIL) test stand is suitable for testing demand, diluter demand, pressure breathing diluter demand, or the miniature pressure breathing demand oxygen regulators having outlet pressures of up to 20 inches of water. Flows are metered over the range of 0-150 l.p.m. Since the Vol-O-Flo manometers of the OTS-565 test stand are calibrated in linear inches of water, all liter-per-minute expressions or measurements must be converted to indicated inches of water through use of the output oxygen Vol-O-Flo element correction curves

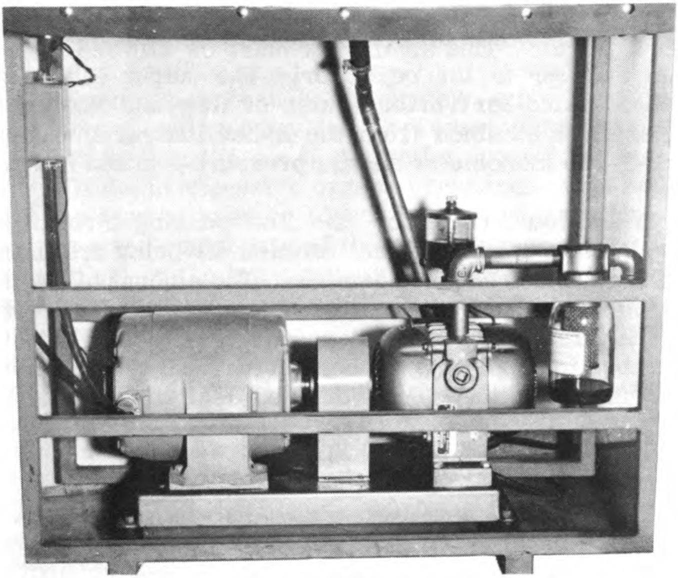


Figure 4-15.—Front view of vacuum pump and motor assembly.

furnished with each test stand. The Vol-O-Flo elements are designed to be as altitude independent as possible, but calibration charts are furnished for all altitudes and must be used. Using these Vol-O-Flo elements, the Vol-O-Flo manometers indicate the amount of air flowing into the chamber to provide the required dilution, and also measure the amount of air-oxygen mixture flowing out of the regulator.

The output valves and vacuum source provide a flow demand on the oxygen regulator, which the suction controlled valve of the regulator attempts to provide. The regulator outlet suction or pressure measured by the pressure-suction manometer indicates whether or not the suction controlled valve of the regulator is performing properly.

In a pressure breathing regulator, a pressure is provided from an additional loading in the regulator controlled by an aneroid element. The pressure breathing characteristics can thus be determined. This is done by evacuating the altitude chamber to the desired altitude by the use of the bypass valve while the outlet valve is cracked to permit a small flow (5 to 10 l.p.m.) through the regulator. This small flow must be allowed to prevent damage to the regulator. The output valves are then adjusted for various rates of flow and suction or pressure is obtained from the indications of the output Vol-O-Flo manometer and the pressure-suction manometer.

In a diluter regulator, the flow passing through the regulator is not all oxygen, dilution air being drawn into the regulator from the chamber. The amount of dilution air is controlled by an aneroid. Through the input valves and input Vol-O-Flo element, air is admitted into the chamber to supply the air being removed by the diluter and thus maintains the desired test altitude in the chamber.

Description of Components

ALTITUDE CHAMBER.—The altitude chamber has a high-pressure oxygen inlet, two chamber pressure taps, a regulator outlet, and an electrical buzzer connection. One chamber tap is connected to one side of the pressure-suction manometer; the other tap is for connection to a barometer, and is capped with a 1/8-inch pipe plug.

PIPING.—The piping consists of two major assemblies, an air inlet assembly which permits air controlled by the air inlet valve to enter the altitude chamber, and a regulator outlet-bypass assembly which permits evacuation of the regulator outlet through an outlet valve, or evacuation of the chamber through a bypass valve. The air inlet hole, which is covered with a fine screen, should never be blocked nor should dirt or dust be permitted near it.

PRESSURE REDUCER.—The pressure reducer supplied with the OTS-565 test stand is designed to regulate supply pressures up to 3,000 p.s.i. This is adequate for setting pressures for regulators designed to be tested with high supply pressures, but may damage regulators designed to operate on only 50 to 150 p.s.i. The difficulty of adjusting and maintaining this low pressure (50 to 150 p.s.i.) with a high-range pressure gage may result in overloading the oxygen regulator. Therefore, for testing of regulators requiring oxygen inputs of only 50 to 150 p.s.i., it is recommended that the test stand low-pressure cutoff valve be opened.

The cutoff valve is connected at the tee where it joins the low-range (200 p.s.i.) gage line. (See fig. 4-16.) Low oxygen inputs can be accurately set on the low-pressure gage without any danger of overloading the gage. At approximately 175 p.s.i. the relief (popoff and bleed) valve will dump excessive oxygen pressure. This relief valve can also be used to bleed the oxygen pressure in the lines after completion of the performance tests. The pressure set on the low-pressure gage (0-200) will also register on the high-pressure (0-3,000) gage, but due to the extreme high-pressure range of the gage, the needle will barely move off the peg.

NOTE: Liquid oxygen regulators should not be tested using this pressure reducer. An auxiliary pressure reducer should be installed at the oxygen inlet. For further instructions, refer to NavAer 17-15BC-505.

Figure 4-16 is a schematic diagram of the pressure reducer and the gage connections. When an adequate supply pressure is turned on, it will always register on the 0-4,000 p.s.i. cylinder pressure gage. Turning the pressure reducer handle clockwise supplies and increases the pressure delivered to the regulator (pigtail) and is registered on the high-pressure delivery gage. Extreme caution must be observed to assure the low-pressure gage cutoff valve is closed when setting pressures in excess of the range (0-200 p.s.i.) of the low-pressure gage.

VOL-O-FLO MANOMETERS.—Two Vol-O-Flo manometers are used in the test stand. Each Vol-O-Flo manometer consists of a Vol-O-Flo manometer element, from which the manometer is connected. One Vol-O-Flo manometer is in the air inlet line downstream from the air inlet valve. The other Vol-O-Flo manometer is in the regulator outlet line upstream from the outlet valve. The two Vol-O-Flo manometers are thus substantially at chamber pressure and are calibrated to give the flows at the ambient altitude (simulated chamber pressure altitude). The Vol-O-Flo manometers are of the linear type in which the pressure drop across the Vol-O-Flo element is directly proportional to the volumetric (ambient) flow. The Vol-O-Flo measuring manometers have a range of about 12 inches of water and are inscribed in linear inches.

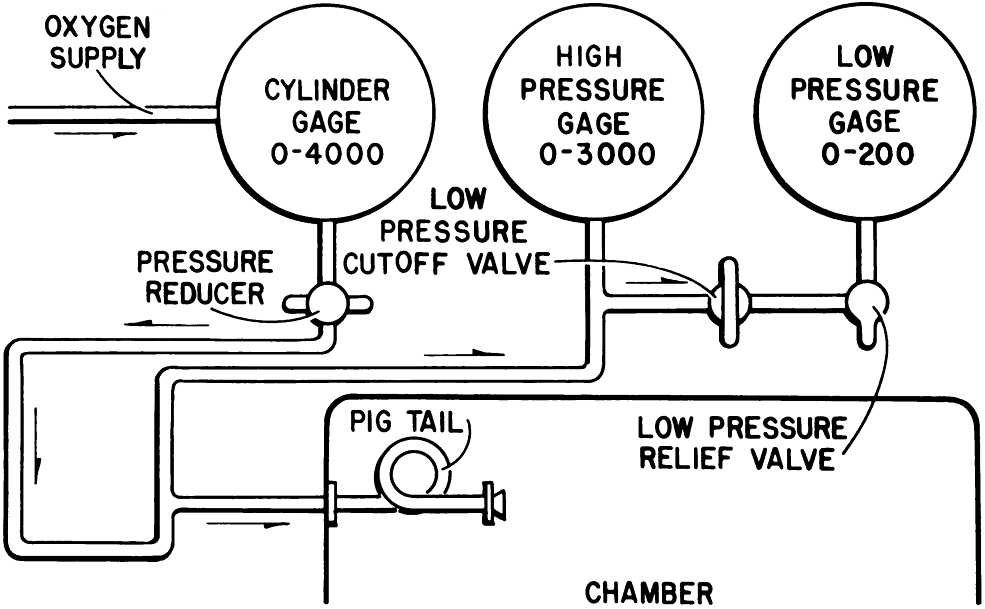


Figure 4-16.—Schematic diagram of pressure reducer and pressure gages for OTS-565 (NIL) test stand.

In addition to the two Vol-O-Flo manometers there is one pressure-suction manometer located on the left side of the test stand. The pressure-suction manometer is calibrated from -4.0 to +20.0 inches of water. The pressure-suction manometer is designed to measure the pressure and suction required to draw a specified flow through the regulator. Excessive pressure or suction to the manometer is equalized by operating the pressure-suction bypass valve, located just above the altitude chamber. (See fig. 4-13, item 16.)

Calibration Charts

Three copies of the calibration charts are supplied with each test stand. For testing diluter demand regulators, a table of test points (ratio performance chart) can be set up. This table can be computed from the Vol-O-Flo element calibration curves and the performance requirements for the regulator, published in the *Handbook of Service Instructions* for the regulator to be tested. An example of such a computation is given in chapter 6.

Once a table has been established for a particular regulator, the operator has no need to make any correction to the Vol-O-Flo manometer readings, other than for temperature variation. The calibration curves show that the ambient flow at any indication varies with gas composition and varies slightly with altitude. The input Vol-O-Flo element calibration depends only on altitude and temperature since only air is passing through the element. Similarly, the output Vol-O-Flo element calibration depends only on altitude and temperature when the regulator is operated with the diluter control turned off, in which case only oxygen is being passed. When the regulator is operated with the diluter control turned on, a variable air-oxygen mixture passes through the output Vol-O-Flo element.

TEMPERATURE CONSIDERATIONS.—On the linear type Vol-O-Flo element, the reading for a given flow is dependent on the gas (air, oxygen, or mixture), altitude, pressure, and temperature. The Vol-O-Flo elements are calibrated at the factory at a specified temperature usually 72° F. If the test stand is operated in the temperature range of 65° F. to 80° F., temperature corrections may usually be neglected.

If greater accuracy is required or if the test stand is used at temperautres outside this temperautre range, a temperature correction may be applied as follows: Determine the temperature for which the test stand was calibrated. If the test stand was calibrated against a field standard calibrator, the temperature of calibration is that for which the field standard correction curves were made. For each degree Fahrenheit the test stand is operating above the calibration temperature, the reading will be too high by 0.15 percent. For each degree Fahrenheit below the calibration temperature, the Vol-O-Flo manometer reading will be 0.15 percent too low. These temperature corrections are in addition to and independent of corrections for altitude or gas mixture.

Preparation for Use

ASSEMBLY.—The OTS-565 (NIL) test stand is shipped in two crates. The test stand proper is packed in one crate, and the pump stand is in the other. Particular attention should be given to careful uncrating to assure that none of the parts are damaged. The pump stand should be assembled first. Insert the oil cup on the top of the pump and tighten. Screw the glass jar in place over the exhaust muffler. Make up a 220-volt, 3-wire, single-phase a-c line, using the 3-prong plug provided. NOTE: Some test stands are being equipped with 220 volt, 3 phase a-c motors.

Connect the a-c line to a power source and start the pump. Be sure the pump is rotating in the right direction as indicated by the arrow. The pump should be given a quick check to see if it is producing good suction. This can be done by placing the hand over the rubber connecting tube, with the pump in operation.

The test stand proper can now be assembled. After removing the back panel and the four mounting bolts, place the test stand on top of the pump stand, oriented so that the electrical connections are on one side and the pump inlet coincides with the chamber outlet connection. Bolt the test stand to the pump stand to make one unit. Connect the leads (buzzer connection) from the pump stand to the terminal provided in the test stand. Slip the vacuum-pump hose over the metal outlet tube of the test stand and tighten the clamps.

MANOMETERS.—Proper and initial adjustments of the manometers and other measuring components are simple but important. Much of the accuracy of the test stand depends upon careful setup procedures. To protect the pressure-suction glass manometer tube during shipment, cotton wads have been inserted between the scale and the glass tube. Do not attempt to move the scale adjustment knob in front of the manometer until this packing has been removed.

After the cotton packing has been removed, replace the manometer panel and scale adjustment knob, and position the scale so that it is near the center of its travel. Remove the Allen head screw from the top of the manometer wells and fill each manometer well with the King blue oil (Sp. Gr. 1.000) packed with the stand. The manometers should be filled to the zero level, using a suitable funnel. Replace the Allen head screws, using a suitable sealer such as glyptal. Care should be observed to avoid contaminating the manometer fluid.

OXYGEN LINE.—The high pressure oxygen line is connected to the pressure reducer by passing the proper end through the hole in the side of the cabinet, after which the free end is connected to an oxygen supply source.

BUZZER AND ALTIMETER.—The operation of the buzzer is checked by simply throwing the switch which is located at the lower left-hand corner. The altimeter index is adjusted to read 29.92 inches of mercury. If there is any doubt as to the accuracy of the altimeter, it should be checked against a master altimeter of known accuracy.

LEVELING.—The level of the test stand is checked by observing the bubble level on the stand. The manometer scales can be adjusted to zero readings by using the knobs provided at the bottom of each manometer.

ADJUSTMENTS.—After all the preliminary assembly steps have been taken and the cover glass has been unwrapped, examined, and set aside for appropriate use, the stand is ready for leakage tests which are conducted before the apparatus is used. The high-pressure oxygen system can be tested for leaks before the chamber is evacuated. This is accomplished as follows:

1. Remove the oxygen inlet pigtail from the elbow fitting and cap with an AN 820 flared tube fitting.
2. Turn on the oxygen supply valve.
3. With the oxygen low-pressure gage cutoff valve closed, adjust the output from the oxygen pressure reducer (clockwise) to 500 p.s.i. The cylinder pressure should be above 1,800 p.s.i.
4. Turn off the oxygen supply valve.
5. Note the rate at which the pressure on the high-pressure delivery gage drops. If the pressure does not drop more than 50 p.s.i. in 30 minutes, the high-pressure inlet system is adequately leaktight; if the leak is excessive, check the leakage at the various joints involved and tighten where necessary. This leakage should be checked occasionally to be certain of a system that is sufficiently leaktight for the required tests.

The altitude chamber, manometers, and Vol-O-Flo elements can be tested for leaks by evacuating the entire system and timing the rate of descent of the altimeter or altitude barometer indication when all valves are closed. In making this test the oxygen inlet should be capped as described above so that the oxygen pressure reducer does not become subjected to the vacuum. If the leakage rate is slow enough that the altitude indication does not decrease by more than 100 feet per minute, the system is adequately leaktight. Concurrent with the above altitude leakage test, the chamber should be evacuated to approximately 50,000 feet to remove dissolved air from the liquid in the manometers. After the completion of these tests, the rear cover can be replaced on the test stand.

STORAGE.—Before the test stand is placed in storage, the manometers should be drained. Consult the manufacturer's handbook for information about this subject which also is related to shipment of the equipment.

Maintenance

INSPECTION.—The test stand should be inspected every 6 months as follows:

1. Inspect all rubber tubing connections. If they show signs of wear or cracking, replace them.

2. Check the rubber sealing gasket around the chamber, wash it with soap and water if necessary. Keep the chamber cover glass clean and free of chips.

3. The altimeter should be checked against a master altimeter or barometer to make certain it is within allowable tolerances.

LEAK CHECK.—Inspect the stand for leakage daily before running any tests. Evacuate to about 50,000 feet, hold for about 2 minutes, and drop the altitude to 40,000 feet. Close the valves fingertight. Time the rate of altitude loss for 5 minutes or more. The leak rate should be less than 100 feet per minute.

VALVE REPLACEMENT.—Remove the handle of the valve to be replaced. Remove the entire valve assembly by freeing its hose clamps and pipe clamps. Unscrew the valve from the piping, taking care not to bend or otherwise damage the assembly. Install a new valve using a suitable thread sealer such as glyptal, maintaining the original orientation of the piping assembly angles. Fit the assembly into the test stand. If the angles of the valve assembly have to be adjusted, again remove the assembly and adjust the angles to make a good fit. Replace all screws and clamps. Check all joints for leakage, tightening where necessary.

VOL-O-FLO ELEMENT CLEANING.—Disconnect the Vol-O-Flo element from the tubes which lead to the Vol-O-Flo manometers. Disconnect the flow element from the rest of the plumbing system by removing the hose clamps and rubber tubes at the ends of the element. Before the element is removed, put a directional mark on it so that on reassembly it will be connected the same way as initially. Using about a gallon of water with a teaspoon of detergent, flush the element in reverse from the direction in which air normally goes through it. For this operation, it is will to cap the two pressure taps on the side of the element to avoid spillage of the cleaning fluid. After the element has been well flushed, the detergent should be rinsed out immediately with clean water. The element should then be replaced in the test stand and air passed through it for about an hour to insure that it is completely dry. After drying the element, the test stand should be leak tested.

MANOMETER CLEANING.—Remove the glass manometer panel. Disconnect rubber tubing attached to the pressure-suction manometer and remove the nuts and washers which secure the manometer to the test stand. Remove the manometer.

In order to remove the dual Vol-O-Flo manometer, it is necessary to first remove the manometer elements and piping.

Preparatory to cleaning, drain the manometer by opening the plug at the bottom of the case. Remove the drain plug and remove the overflow check valve at the top of the case. Pass a cylindrical tube cleaning brush soaked in alcohol completely through the tube several times. Rinse with clean alcohol and blow the tube dry, using very dry air or gas. If dry gas is not available, permit the tube to air dry naturally. Do not wipe the inside of the tube, or blow it out with your breath. The overflow check valve should be soaked in alcohol until all dirt and particles are removed.

The well can be cleaned with a brush soaked in alcohol after removing the large cleanout plug on the back of the well. Rinse the well with fresh alcohol and dry as above. Reassemble the manometer and replace on the stand. Refill with King blue oil to the approximate zero level.

INTERCOMPARISON.—The inlet and outlet Vol-O-Flo manometers should be intercompared every 2 weeks, or before use of the stand if it has been idle for a period of more than 2 weeks. Cap the oxygen supply fitting in the chamber and evacuate the chamber to about 5,000 feet. With the bypass valve closed, adjust the flow to each, 5, 50, and 85 l.p.m., maintaining the simulated pressure altitude constant. Record the inlet and outlet indications simultaneously. Repeat this procedure at 15,000 and 30,000 feet. After applying the corrections in the existing calibration charts, the flows should agree to within 2 percent or 1 l.p.m., whichever is greater. If they differ by more than this for any test point, the manometers should be cleaned as previously described, and recompared. If the agreement is still unsatisfactory, the flow elements should be recalibrated at the factory. It is important that these tests be conducted so that the chamber altitude is not changing when readings are taken. Also time should be permitted for the chamber temperature to equalize to within approximately 33° F.

Gast Vacuum Pump

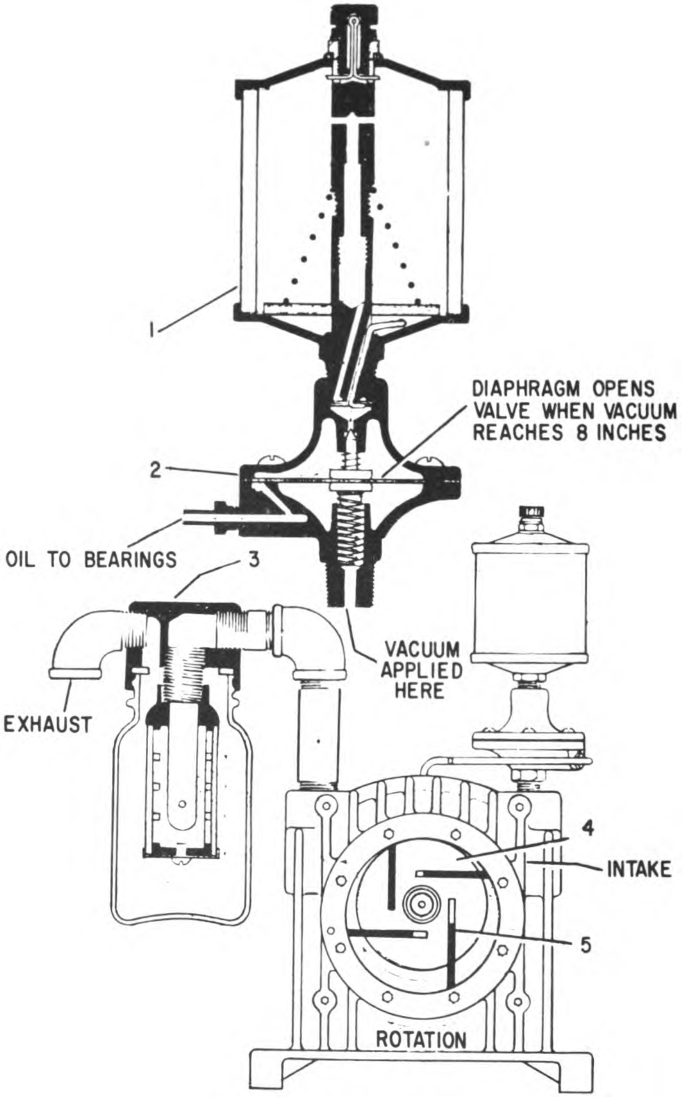
CONSTRUCTION.—The rotary Gast pump is a precision product, there being only 0.0015 to 0.0065 inch total clearance at the ends and top of the rotor. The vanes take up their own wear and should last from 5,000 to 25,000 hours operation, depending upon the application. Remember that it is designed for pumping dry air. Protect it against the entrance of dirt and excessive moisture. Lubricate it regularly and properly, and you will receive years of trouble-free service.

INSTALLATION.—The location of the Gast pump should be on a solid base plate, preferably of metal, which in turn should be anchored to a shelf, the floor, a foundation, or to other machinery. To save time and inconvenience, place the pump so as to provide access to the oil reservoir and large glass oil trap.

Notice that standard rotation is counterclockwise, with the pump shaft extending toward the viewer. (See fig. 4-17.) Use sufficient horsepower. Figures in the manufacturer's tables call for pump speed of 1,750 r.p.m. unless otherwise specified. For direct drive, study the drawing and align the pump and motor shafts. For V-belt drive, remove the fan and guard from the drive end so that the sheave may be installed nearer the bearing. Speed may range from 1,000 to 1,800 r.p.m., but choose a pump sheave of good diameter, such as 4 to 5 inches.

Connections are standard pipe thread. Avoid the use of extra elbows in the line, and give the line a uniform slope. Place a drain cock at the low point. For ease of servicing, use a union or hose with clamps near the pump. A hose helps eliminate noise and vibration. The muffler may be removed and the exhaust piped directly out of the building.

LUBRICATION.—The instructions are affixed on the oiler glass. Use a light oil or pure mineral oil without additives, having a viscosity equivalent to S.A.E. 10. For installations in warm climates or where room temperature is high, use heavy medium oil having a viscosity



PUMP INTERIOR

Figure 4-17.—Interior and cross section view of vacuum pump (Gast).

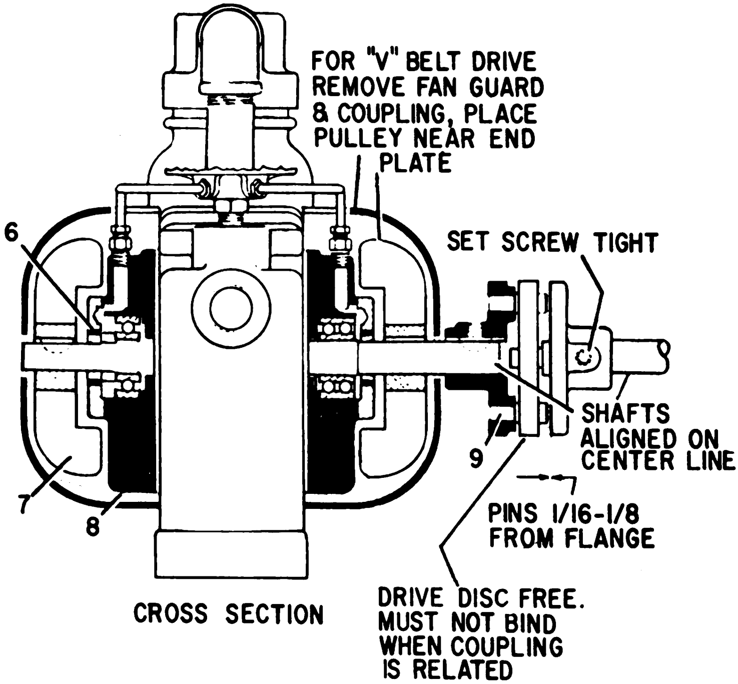

FOR "V" BELT DRIVE REMOVE FAN GUARD & COUPLING, PLACE PULLEY NEAR END PLATE
SET SCREW TIGHT
6
SHAFTS ALIGNED ON CENTER LINE
9
7
8
PINS 1/16-1/8 FROM FLANGE
CROSS SECTION
DRIVE DISC FREE. MUST NOT BIND WHEN COUPLING IS RELATED

Figure 4-17.—Interior and cross section view of vacuum pump (Gast)—Continued.

1. Oil reservoir assembly.
2. Vacuum lubricator assembly.
3. Exhaust muffler and oil trap. (Standard equipment on all pumps.)
4. Rotor and shaft.
5. Vanes (four required).
6. Shaft seal, drive end.
7. Cooling fan, dead end.
8. Rotor and shaft.
9. Flexible drive coupling assembly.

equivalent to S.A.E. 20 or 30. For installations below freezing, change to arctic or dilute a slightly heavier oil with 1/4 or less kerosene. Additives in some oils (especially S.A.E. automotive types) may cause corrosion on any metal parts contacted or leave a jelly-like deposit in oiler and pump chamber. On vacuum operation below 10 inches, a different type of lubricator is required. One filling of the oil reservoir should last 50 to 200 hours operating time, depending upon the application.

SERVICING.—If vacuum builds up slowly, examine the connecting lines for leaks. Vanes may be sticking in slots due to lack of oil, too much oil, or the oil may be too heavy. Flush by permitting several teaspoonfuls of kerosene to be drawn into the intake while the pump is running. Lubricate as previously described. Removing the end plate, preferably opposite the drive shaft end, will permit the removal of the 4 sliding vanes for a thorough cleaning in a solvent and also provide accessibility to any particles which must be removed. The original gaskets are onionskin. Only a few thousandths clearance is required, and any thicker gaskets will greatly reduce the pump efficiency.

CLEANING.—Exhaust and intake filter felts may be removed and washed in solvent. Stop the pump first, otherwise dirt may be sucked into the pump.

INSPECTION.—Periodical inspection will prevent expensive repairs. Do not be alarmed if the pump temperature reaches 150° to 250° when running continuously. If exhaust fog is objectionable, remove the muffler and pipe exhaust out of building. Occasionally, examine the shaft for side or end play by moving it manually while the pump is idle. If the pump or motor shows evidence of overheating or excessive noise, stop immediately until the pump is repaired. In remote locations, it is a good practice to have a spare pump on hand.

Oil Reservoir

FILLING AND OPERATING.—It is easier to fill the oil reservoir while the pump is running. Use an oil can with a slender spout and push it through the side hole inside the filler opening at a 45-degree angle. (See fig. 4-18.) If possible, extend the spout clear of the center post so the oil will not run into the air equalizer passage in the post. To avoid the oil reaching the air equalizer hole, do not fill above the bottom of the top flange. Do not replace the oil filler cap immediately after refilling. Let the pump run a few minutes so any excess oil will be sucked out of the equalizer passage. When this has been done, replace and tighten the filler cap. Each time

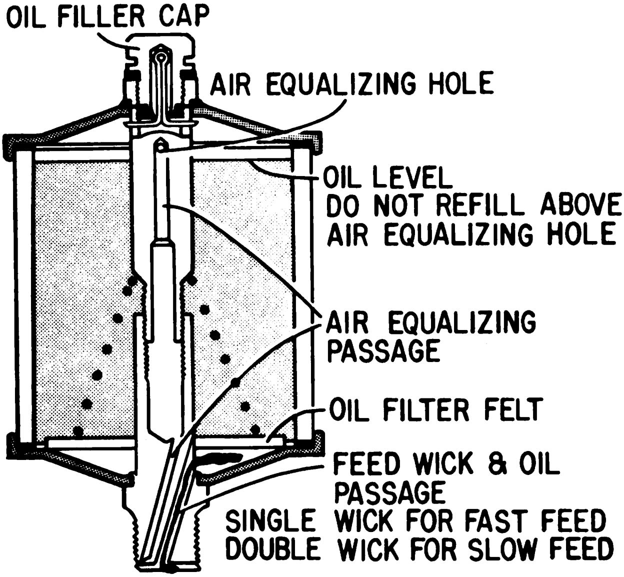


Figure 4-18.—Oil reservoir, Gast vacuum pump.

the pump is oiled, empty the exhaust trap. Do not use this oil again as it usually contains condensed moisture.

OIL FEED CONTROL.—A simple gravity oiling system depends upon keeping the air equalizer passage open and on the choice of wicks (smokers' pipe cleaners). The standard feed uses a double wick on small 4-ounce capacity cups, and a single wick on large 8-ounce cups. In this way, one filling lasts equally as long for both cups. The above wick selection can be changed on special applications.

IMPROPER FEED.—Improper feed might be caused by an oil filled equalizer passage, loose filler cap, or a defective wick. Change wicks if they appear defective. To change the wick, unscrew the oil reservoir from the lubricator casting and pull the oil wick out of the bottom, using pliers. Insert a new wick (if double, insert doubled end first) from the bottom until it touches the filter felt. Cut off the end so it extends for about 1/8 inch beyond the hole. BE CERTAIN THAT THE WICK IS PLACED IN THE CENTER HOLE AND NOT IN THE SIDE HOLE. (See fig. 4-18.)

OTS-566 (NIL) TEST STAND

The OTS-566 Test Stand is designed for testing diluter demand oxygen regulators under simulated altitude conditions. It was designed especially for use aboard ship, but can be used ashore as well. The OTS-566 incorporates Vol-O-Flo gages instead of manometers, otherwise, it is practically identical to the OTS-565. These gages require no fluid, thus the roll of the ship has no effect on the readings.

Description of Components

The test stand consists of an upper cabinet mounted on the lower pump stand. The upper cabinet contains the altitude chamber, control valves, flow measuring gages, pressure-suction gage, altimeter, and piping. The lower pump stand contains a Gast vacuum pump identical to the pump used with the OTS-565. Front and rear views of the stand are shown in figures 4-19 and 4-20.

ALTITUDE CHAMBER.—An airtight chamber, mounted from the rear of the test stand panel, provides a space within which the various test altitudes may be simulated. The chamber is sealed by a cover plate, which rests on rollers, and can be clamped to the front of the chamber. The chamber has eight connections—a high-pressure oxygen inlet, an air inlet, two chamber pressure taps, a regulator outlet pressure tap, bypass outlet, and an electrical buzzer connection. One chamber pressure tap is connected to a barometer and is capped with a 1/8-inch pipe plug.

PIPING.—The piping consists of two major assemblies—an air inlet assembly and a regulator outlet-bypass assembly. The air inlet assembly is controlled by the air inlet valve and allows air to enter the altitude chamber. The outlet-bypass assembly permits either evacuation of the regulator outlet through an outlet valve, or evacuation of the altitude chamber through a bypass valve. The outlet-bypass piping assembly is connected to the pump in the lower cabinet by means of a rubber tube.

There is also an oxygen pressure reducer assembly installed in the test stand and connected to supply oxygen

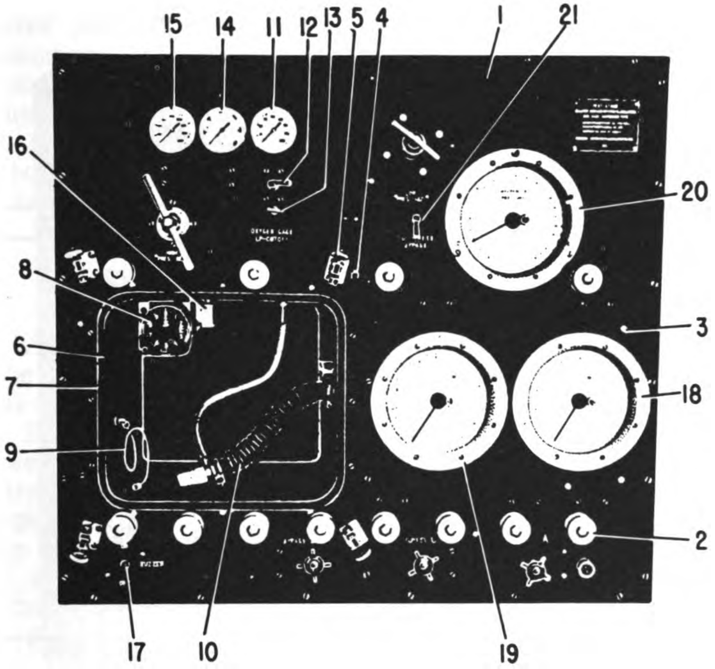


Figure 4-19.—Front view of the OTS-566 test stand panel.

1. Instrument panel.
2. Roller supports.
3. Glass end stops.
4. Glass mid stop.
5. Toggle clamps and spacers.
6. Altitude chamber.
7. Chamber seal gasket.
8. Altimeter.
9. Regulator pigtail.
10. Corrugated rubber tube.
11. 200 p.s.i. gage.
12. Relief valve.
13. Oxygen cutoff valve.
14. 3,000 p.s.i. gage.
15. 4,000 p.s.i. gage.
16. Buzzer.
17. Buzzer switch.
18. Input gage.
19. Output gage.
20. Pressure-suction gage.

to the regulator under test. This assembly includes two regulators, a tank pressure gage, low and high range downstream pressure gages, an oxygen cutoff valve, a check valve, and a combination popoff and manual relief valve.

CONTROL VALVES.—Three needle valves are used. One, in the air inlet assembly, permits air to be bled into the altitude chamber, either to maintain a chamber altitude when the regulator is removing air from the

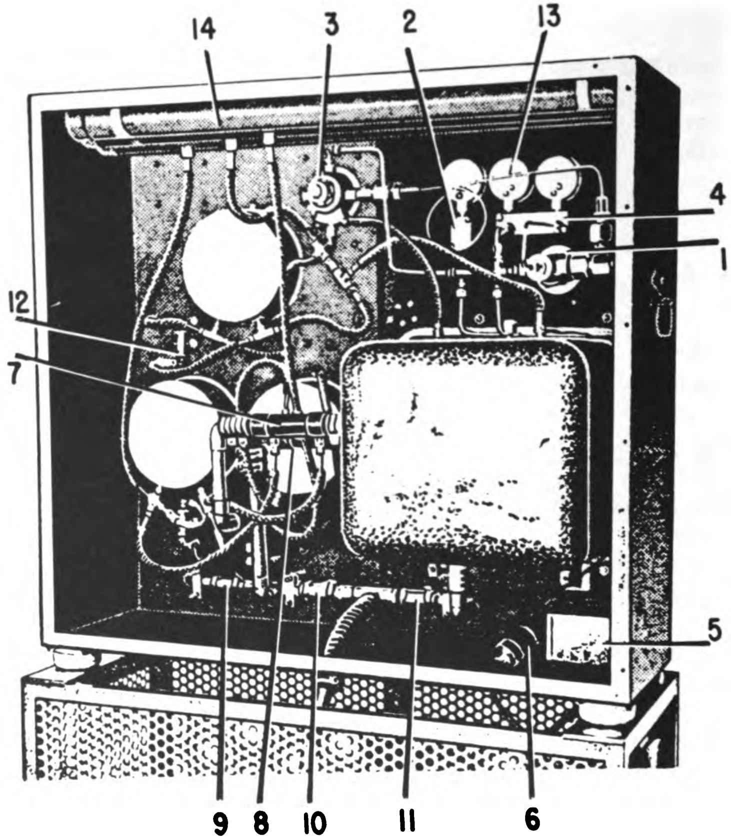


Figure 4-20.—Rear view of the OTS-566 test stand.

1. Oxygen pressure reducer.	8. Output Vol-O-Flo element.
2. Gage mount block.	9. Inlet valve.
3. Oxygen pressure reducer.	10. Outlet valve.
4. Gage mount block.	11. Bypass valve.
5. Transformer, 220, 440 V.	12. Check valve.
6. Loctal plug.	13. Pigtail reducer.
7. Input Vol-O-Flo element.	14. Ballast tank.

chamber through its diluter air valve, or to permit bringing the chamber back to atmospheric pressure from a simulated altitude. The other two valves are in the outlet-bypass assembly. The outlet valve controls the flow of air-oxygen leaving the regulator. The bypass valve permits independent evacuation of the altitude chamber. It is used only to evacuate the chamber to change altitudes above 30,000 feet, or in an emergency when the pressure-suction gage has been overloaded.

FLOWMETERS.—The two flowmeters (Vol-O-Flo elements) used in this test stand are the same as those described for the OTS-565 test stand.

Preparation for Use

ASSEMBLY.—The OTS-566 is shipped in 2 crates. The test stand is assembled the same as the OTS-565, assembling the pump stand first.

POWER REQUIREMENTS.—This text stand requires less than one KVA power. The OTS-566 test stand is wired for 440-volt operation. For operation on 440-volt, 3-phase power sources, bring a 3-wire line directly into the motor starting switchbox and connect the 3 phases. Be sure to check the direction of rotation of the pump as indicated by the arrow.

For operation on 220-volt, 3-phase a-c power sources, make up a 220-volt 3-wire line directly to the motor starting switchbox. Remove the 2 terminal overload elements from the switch and insert the 2 spare elements furnished. Remove the plate from the motor junction box and make up new connections as shown on the motor nameplate.

SETTING THE GAGES.—These new gages provided on the OTS-566 test stand have sensitive diaphragms inside them and may read slightly off zero when the unit is received. If this is true, clamp the glass to the front of the chamber, open the inlet valve, close the outlet and bypass valves, turn on the pump, then slowly open the outlet valve until the inlet and outlet flow gages read approximately 9 inches. The flow measuring gages have a range of 12 inches of water and are inscribed in linear inches. Close the outlet valve and again observe if the gages read other than zero. If so, unscrew the plug (on the dial glass) and use a screwdriver to turn the zero setting screw. After the gage is set to zero, the plug should be replaced.

ADJUSTMENTS.—Before using, the entire apparatus should be tested for leaks. The high-pressure oxygen system can be tested for leaks before the chamber is evacuated. This can be done by following the instructions for adjustments given on the OTS-565.

SPACE REQUIREMENTS.—Floor space 16 x 35 inches is required for the test stand. An additional 15 to 20 inches should be allowed for the high-pressure oxygen cylinder to stand at the end of the test stand, and an additional 30 to 40 inches should be allowed in front of the stand for the operator to occupy. The total work space allocated for the test stand should in no event be less than 50 x 50 inches.

Operation Instructions

The principles of operation for the OTS-566 (NIL) test stand are the same as those outlined for the OTS-565. Keep in mind that the only major change or difference in these two test stands is that the OTS-566 test stand utilizes gages instead of manometers.

LIQUID OXYGEN CAPACITANCE GAGE TEST STAND

The latest type indicators for a liquid oxygen system are of the electric type. Some of these indicating systems are made up of several components, any one of which may become faulty. Since the pilot relies on this indicating system to give true readings, there has to be some means for checking the various components to insure the proper functioning of each. In order to accomplish this, the liquid oxygen capacitance gage test stand was designed to insure a high degree of reliability for checking the electrical components of liquid oxygen systems.

Description

This test stand is a counter type unit with the control panel mounted above the counter as shown in figure 4-21. There is an inverter housed below to provide all necessary operating voltages.

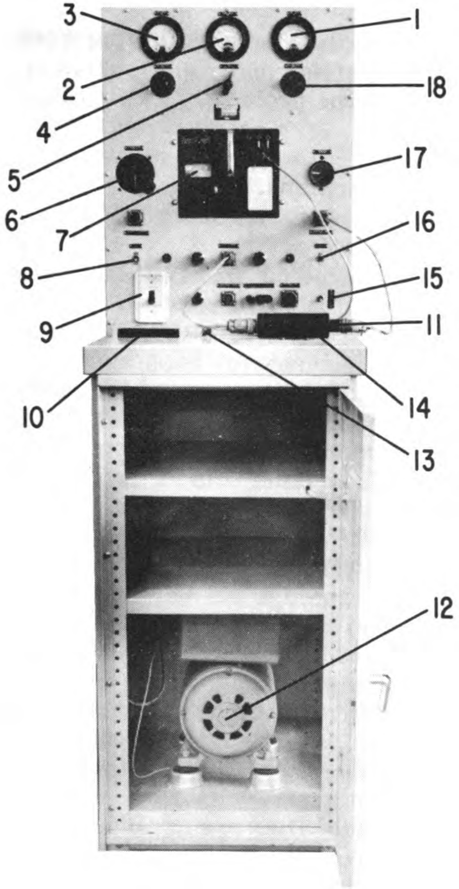


Figure 4-21.—Liquid oxygen capacitance gage test stand.

1. High voltage 115-volt meter M-3.
2. Power supply meter M-2.
3. Low voltage 26 volt meter M-4.
4. VAR 1.
5. Test switch.
6. Transmitting synchro.
7. Precision capacitor. Drum on left, scale on right.
8. Low voltage 26 volt switch.
9. Starter switch.
10. Master microammeter.
11. Preamplifier, behind amplifier.
12. Inverter.
13. Current adjustment potentiometer.
14. Amplifier.
15. M-3 meter switch, low or high.
16. High voltage 115-volt switch.
17. Receiving synchro.
18. VAR II.

This test stand checks the following components of the liquid oxygen system:

1. Capacitance type probes.
2. Preamplifier.
3. Amplifier.
4. Amplifier indicators.
5. Nonservo probe transmitters.
6. Synchro type indicators.
7. Ammeter type indicators.

Components

In order to completely understand the operation of the liquid oxygen capacitance gage test stand, a thorough knowledge of the nomenclature of the component is needed. (See fig. 4-21.) This stand acts in the same capacity as the actual setup of the aircraft system.

PRECISION CAPACITOR.—The precision capacitor (7) acts in the same capacity as a probe does in a converter. Values are inscribed on a drum and dial in micro farads, and the values are set for the various tests. The drum is graduated from 100 to 1150 UUF. Actual readings are taken when the cable is plugged into the high side of the capacitor. For correct readings when the cable is plugged into the low side of the capacitor, the zero should be dropped from the reading. The dial is graduated from 0 to 50 for fine adjustments.

PREAMPLIFIER.—The preamplifier (11) amplifies signals received from the preamplifier, the same as the amplifier in an aircraft system.

RECEIVING SYNCHRO.—The receiving synchro (17) receives signals from the amplifier and acts in the same capacity as the indicator does in the aircraft system. The only difference is that the receiving synchro is calibrated in degrees.

METERS.—There are 3 meters (1, 2, & 3) located across the top portion of the test stand. These meters show the various electrical voltages which are controlled by VAR I (voltage amperes reactor) and VAR II (4 & 18).

TEST SWITCH.—The test switch (5) is used to make the proper internal connections for testing the various components. This is a two-position switch, with positions TX or IND.

VOLTAGE SWITCHES.—There are 3 voltage switches utilized on the stand; their functions are:

The 26-volt switch (8) connects the power to the M4 meter (3).

The 115-volt switch (16) connects the power to the M3 meter (1).

The M3-switch (15) controls the high or low voltage to the inverter (12).

TRANSMITTING SYNCHRO.—The transmitting synchro (6) controls the test signals for checking synchro type indicators, this acts in the same capacity as the precision capacitor does for probes. The transmitting synchro is calibrated in degrees, ranging from 0 to 360.

MASTER MICROAMMETER.—The master microammeter (10) measures the current output of probe transmitters and ammeter type indicators, whichever is under test. The master microammeter is calibrated from 0 to 50 microamperes.

CURRENT ADJUSTMENT POTENTIOMETER.—This potentiometer (13) adjusts the current to the ammeter type indicators under test. The current adjustment potentiometer is used only with the test switch in the IND position.

CABLES.—There are 12 different cables furnished with the liquid oxygen capacitance gage test stand. The cables are used in different sets for connecting the various components to the test stand.

Types of Tests

FUNCTIONAL TEST.—The functional test is the operational test for the test stand. The functional test is to be performed each time the test stand is used. The procedure for performing the functional test follows:

1. Connect cable No. 1 to the precision capacitor and preamplifier.
2. Connect cable No. 3 to J7 (source of power), preamplifier, and amplifier.
3. Connect cable No. 4 to J9 (input to receiver synchro) and amplifier.
4. Turn starter switch to ON.
5. Set test switch to TX.

6. Turn the 115-volt switch to ON.

7. Set the M3-switch to 115 volts.

8. Adjust VAR II until the reading is 115 volts on the M3 meter.

9. Set the precision capacitor to first value of 65 UUF (microfarads). The reading on the receiver synchro should be 90°.

10. Set empty (bottom) screw on the adjustment potentiometer on preamplifier.

11. Set the precision capacitor to upper limit of 95 UUF. The reading on the receiver synchro should be 270°.

12. Set full (top) screw on the adjustment potentiometer on preamplifier.

13. Check the full range, readjust the preamplifier until synchro tracks, as indicated below:

65 UUF	90°
71 UUF	126°
77 UUF	162°
83 UUF	198°
89 UUF	234°
95 UUF	270°

CAPACITANCE PROBE TEST.—This test is for checking the capacitance type probes, and is performed as follows:

1. Connect the test stand in the same manner as for the functional test, but substitute the probe for the precision capacitor.

2. Follow the same procedure as given for the functional test.

3. Immerse the probe in liquid oxygen.

4. The readings are taken off the receiver synchro.

NOTE: The probe is to be immersed to the depth listed in the handbook for whatever type of probe under test.

PREAMPLIFIER TEST.—The preamplifier test is accomplished by substituting the aircraft system preamplifier for the test stand preamplifier and performing the functional test.

NOTE: For GV-2 preamplifier, use cable No. 2 in place of No. 1. Use cable No. 5 as an adapter between cable No. 3 and GV-2 preamplifier.

AMPLIFIER TEST.—To test the aircraft amplifier, substitute it for the amplifier on the test stand and perform the functional test.

AMPLIFIER INDICATOR TEST.—To check amplifier type indicators, disconnect cable No. 3 from the test stand amplifier and connect it to the inverter under the stand. Perform the functional test.

NONSERVO PROBE TRANSMITTER TEST. To test nonservo probe type transmitters, perform the following steps:

1. Connect the probe to J1 jack on the test stand with cable No. 7.
2. Turn starter switch ON.
3. Set test switch to TX.
4. Turn the 115-volt switch ON.
5. Set the M3 switch to 115 volts.
6. Adjust VAR II to read 115 volts on the M3 meter.
7. Allow the equipment 10 minutes to warm up.
8. Set the M3 switch to 15 volts.
9. The M3 meter should read about 6.3 volts.
10. The M2 meter should read 96 ± 5 volts.
11. Immerse the probe in liquid oxygen to a depth specified by the handbook for the probe being tested.
12. Take the reading from the master microammeter.

AMMETER INDICATOR TEST.—The procedure for testing ammeter type indicators follows:

1. Connect the indicator to J2 jack on the test stand with cable No. 8.
2. Repeat steps 1 through 10 given for the nonservo probe transmitter test, except set the test switch to IND.
3. Set the current adjustment potentiometer for the first master microammeter reading.
4. The readings are taken from the master microammeter at remaining current settings.

5.0 ± 0.5	Empty
21.9 ± 1.5	1/4 full
30.4 ± 1.5	1/2 full
38.7 ± 1.5	3/4 full
46.0 ± 1.5	Full

SYNCHRO INDICATOR TEST.—The procedure for testing the synchro type indicators follows:

1. Connect the indicator to the test stand jacks No. 7 and 8.

2. Turn starter switch ON.
3. Set test switch to TX.
4. Turn the 26-volt switch ON.
5. TURN the 115-volt switch ON.
6. Adjust VAR I for 26 volts on the M4 meter, and VAR II for 115 volts on the M3 meter.
7. Set the transmitting synchro at the following different values:

90	0 liter
126	1 liter
162	2 liters
198	3 liters
234	4 liters
270	5 liters

LIQUID OXYGEN CONVERTER BUILDUP FLOW, AND HEAT LOSS TEST STAND

The liquid oxygen converter must be able to store liquid oxygen and deliver gaseous oxygen of the correct breathing temperature to the user as required. These factors are dependent on the converter being in reliable working condition.

The liquid oxygen converter buildup, flow, and heat loss test stand (hereafter referred to as test stand) was specifically designed to insure a high degree of reliability for the liquid oxygen converter by providing the means for periodic preventive maintenance tests and adjustments.

Description of Components

The test stand, shown in figure 4-22, consists of the test stand proper, a scale, and a pressurized heat loss kit. This test stand was designed to test all known low-pressure liquid oxygen converters currently in use by the Navy.

FLOWMETER.—The test stand has a variable area glass tube type flowmeter (3). It is graduated from 20 to 210 l.p.m. There are additional graduations above and below these figures to read as low as 10 l.p.m., and as high as 216 l.p.m. The flowmeter records the rate of flow of gaseous oxygen from the converter.

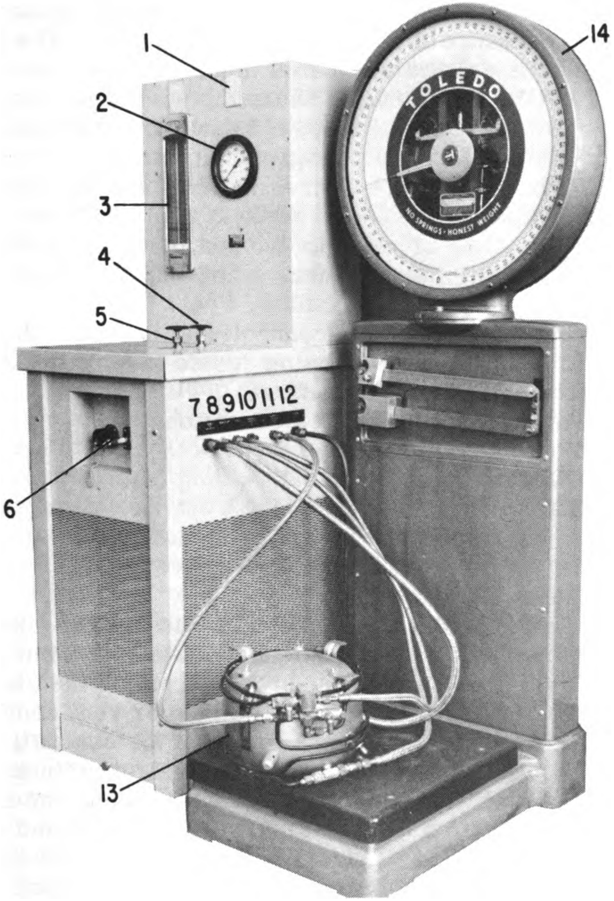


Figure 4-22.—Liquid oxygen converter buildup, flow, and heat loss test stand.

1. Correction cards.
2. Pressure gage.
3. Flowmeter.
4. Supply valve for converter without coil.
5. Supply valve for converter with coil.
6. Buildup and vent valve.
7. Connection, vent to converter.
8. Connection, buildup to converter.
9. Connection, fill to converter.
10. Connection, supply valve with coil to converter.
11. Connection, supply valve without coil to converter.
12. Test stand vent.
13. Converter being tested.
14. Scales.

PRESSURE GAGE.—The pressure gage (2) records the internal pressure of the converter under test. The pressure gage is calibrated from 0 to 160 p.s.i.

EVAPORATOR COIL.—There is an evaporator coil built into the bottom of the test stand for converters that do not have a coil as an integral unit.

SUPPLY VALVES.—There are two supply valves (4 and 5) located on the bed of the test stand. These valves control the flow of gaseous oxygen. One valve is to be used with converters without a coil and the other is for use on converters with a coil.

CONNECTIONS.—The connections between the test stand and the converter being tested are located on the right side when facing the stand.

Following is a list of the connections:

Vent to converter (7).
Buildup to converter (8).
Fill to converter (9).
Supply valve with coil to converter (10).
Supply valve without coil to converter (11).
Test stand vent (12).

BUILDUP AND VENT VALVE.—The buildup and vent valve (6) is located below the bed and on the front of the test stand. This valve is used to place either the stand or the converter being tested in the buildup or vent condition.

SCALES.—The scales are provided for conducting the evaporation heat loss tests by the weight method. The scales are an integral part of the test stand for determining evaporation heat loss under both vented and pressurized conditions. The dial face is graduated in one-ounce increments from 0 to 75 pounds. With a tare poise and a capacity poise on the scale it can show weights up to 150 pounds.

The scale is an extremely sensitive, nonspring, weight-indicating device. There is a locking handle located in rear of the scale. The handle should be kept in the locked position when the scale is not in use to prevent damage to the scales.

PRESSURIZED HEAT LOSS KIT.—The pressurized heat loss kit is used for performing the heat loss test on converters under pressurized conditions. The components of the kit include a pressure gage calibrated from 0 to 200 p.s.i., flexible metal hose, plugs, and connectors.

All tests performed on converters must be performed in reference to the operating manuals for whatever particular converter being tested. All converters do not fall within the same limits as to pressure, flow, heat loss, and filling time.

CONNECTION PROCEDURE.—The proper steps for connecting the converter to be tested follow:

1. Connect the flexible hose from the converter connector on the test stand to the gas vent port on the converter.
2. Connect the hose from the buildup connector on the test stand to the buildup connector on the converter.
3. Connect the hose from the fill connector on the test stand to the fill connector on the converter.
4. Connect the flexible hose from the supply converter with the coil connector on the test stand to the supply connector on the converter to be tested; that is, if the converter has its own evaporating coil. If the converter does not have its own coil, make use of the coil on the test stand by connecting to the supply converter without coil connector. When using supply converter connections, make sure that the alternate supply valve on the test stand is closed. Never plug, cap, or obstruct the converter pressure relief vent.

When the converter is connected to the test stand in this manner, filling, buildup, and flow tests can easily be performed.

FILLING CONVERTER.—Prior to beginning the tests on the converter, it should be filled in the following manner:

1. Place the converter on the scales and have it connected as listed in the connection procedure.
2. Place the test stand buildup and vent valve in the vent position. If the converter has a buildup and vent valve, it is also to be placed in the vent position.
3. Make certain that both test stand supply converter valves are closed.
4. Connect the transfer hose to the test stand filler valve.
5. Regulate the transfer pressure between 25 and 35 p.s.i. and admit liquid oxygen until a steady stream flows from the test stand vent connection.

6. Disconnect the transfer hose.

PRESSURE BUILDUP TEST.—The buildup test is to determine if the converter under test reaches the operating pressure in the required length of time for whatever particular converter is being tested. The procedure for performing this test follows:

1. Place the test stand buildup and vent valve in the buildup position and record the time started. If the converter being tested has a buildup and vent valve incorporated, it is to remain in the vent position.
2. Record the time that the pressure gage reaches the specified operating pressure. Compare the time interval with the performance specifications for the applicable converter to determine pass or fail condition.

FLOW TEST.—The flow test is to determine if the converter delivers the required amount of flow of gaseous oxygen to the user, as specified by the manual for the particular converter being tested. The procedure for performing the flow test follows:

1. With the converter connected in the proper manner, slowly open whichever supply valve on the test stand is associated with the type of converter (with or without coil).
2. Set the specified rate of flow from the manual for the type of converter being tested on the flowmeter.
3. Maintain this flow for the specified time and check the test stand pressure gage for the specified tolerance.
4. Slowly close the supply valve being used, and place the buildup and vent valve in the vent position.

VENTED EVAPORATION HEAT LOSS TEST.—The heat loss test, either vented or pressurized, is to determine if the converter under test falls within the specified limits as to the allowable evaporation.

Make certain of the following connections.

1. Connect the flexible hose from the filler connection on the test stand to the filler port on the converter.
2. Connect the flexible hose from the vent to converter on the test stand to the gas port on the converter.

All other converter ports except the pressure relief vent will be capped or plugged.

3. Fill the converter through the test stand as previously given.
4. Unlock the scale locking handle by turning 1/4 turn clockwise, and record the weight of the filled converter.

If the specifications for the converter being tested calls for a stabilization period, wait for exactly this time and then record the weight of the converter. This period will usually be 1 or 2 hours.

5. Allow the converter to remain at rest for the specified time interval, which is usually 24 hours, then record the weight again.

6. Check the weight loss with the specifications for the converter.

If the specifications give the loss in liters, divide the weight loss by 2.48 pounds to convert weight to liters.

PRESSURIZED EVAPORATION HEAT LOSS TEST.—The procedure for testing a converter under pressure follows:

1. If the converter is still 75 percent full from the previous test, proceed to this test; if not, refill the converter.

2. Remove the plug from the converter supply port and attach the 0 to 200 p.s.i. pressure gage to this port.

3. Connect the flexible hose between the vent gas port on the converter and the buildup port on the converter. Check that all other ports except the pressure relief vent are either plugged or capped.

4. Record the weight of the converter and allow it to remain at rest for the specified time. Record the weight again after duration of the test period called for in the specifications.

5. Loosen the flexible hose from the fitting on the converter vent port, releasing all the pressure, then disconnect the opposite end. Remove the pressure gage and all the remaining plugs or caps.

LEAK TEST ON THE TEST STAND.—In order to insure that the test stand is always in maximum working condition, a leak test is to be performed weekly in the following manner:

1. Plug the outlet port of the flowmeter.

2. Plug the open end of the flexible hose connected to the supply converter without the coil connection.

3. Interconnect the hose between the supply converter with the coil connector and the buildup connector.

4. Place the buildup and vent valve in the buildup position.

5. Open both supply converter valves.

6. Connect gaseous oxygen supply with an adjustable regulator to the vent to converter connection on the test stand.

7. Apply 150 p.s.i., which is read on the test stand pressure gage.

8. Allow the pressure to remain for 10 minutes. The allowable loss in pressure is 5 p.s.i. If there is excessive loss, soap all the fittings to find the leak.

Maintenance

Very little maintenance is necessary on this test stand. One of the most important preventive maintenance items is to keep the equipment clean and free from oil and dust.

SCALE.—The scale should be lubricated occasionally at the dash pot and the lower oil seal. The zero adjustment is through the hole on the left side of the scale. No further adjustment should be attempted on the scale.

PRESSURE GAGE ADJUSTMENT.—The pressure gage should be checked daily to determine if it reads zero with no pressure applied. To adjust the gage, remove the back cover of the test stand and turn the adjusting screw through the hole in back of the gage until the pointer indicates zero.

CALIBRATION OF THE FLOWMETER AND PRESSURE GAGE.—The calibration of the flowmeter and pressure gage is to be conducted monthly, in the following manner:

1. Connect the master flowmeter to the supply converter with the coil connection and pass the specified flows through flowmeter. Make out correction cards if necessary.

2. Connect the master pressure gage to the buildup connection on the test stand and set the specified pressures on the master gage. Make out correction cards if necessary.

LIQUID OXYGEN ACCESSORIES TEST STAND

The lives of the pilot and crew and the success of a mission are dependent on the continuous supply of oxygen.

These factors, in turn, are dependent upon the reliability of the liquid oxygen system. The liquid oxygen accessories test stand was designed to insure a high degree of reliability for the converter components and accessories by accurately testing them for proper performance. The test stand is shown in figure 4-23.

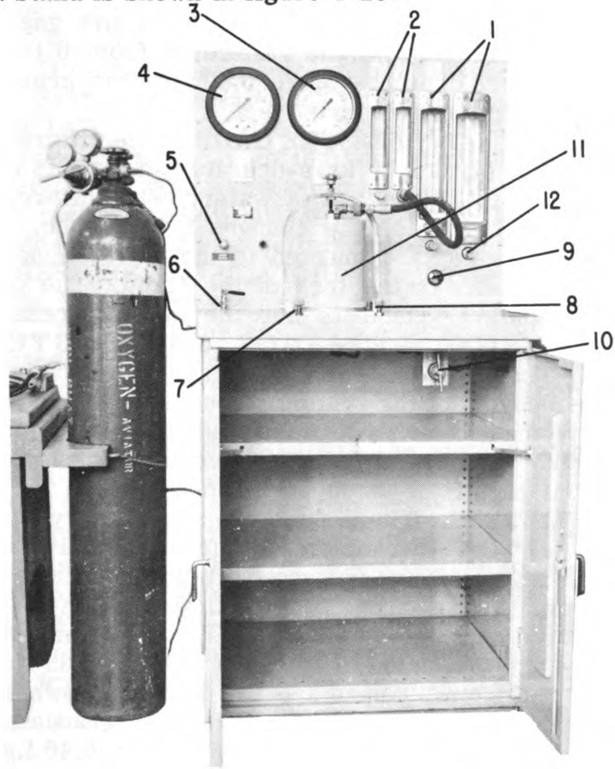


Figure 4-23.–Liquid oxygen accessories test stand.

1. High range flowmeters.
2. Low range flowmeters.
3. Pressure gage.
4. Differential pressure gage.
5. Bleed valves for differential pressure gage.
6. Shutoff valve for differential pressure gage.
7. System bleed valve.
8. Oxygen supply valve.
9. Oxygen supply gage.
10. Pressure reducer.
11. Bell jar.
12. Male portion of disconnect.

SUPPLY PRESSURE GAGE.—The supply pressure gage (9) is calibrated from 0 to 2,000 p.s.i. This gage indicates the remaining pressure in the supply cylinder.

TEST PRESSURE GAGE.—The test pressure gage (3) is bourdon-tube-operated and calibrated from 0 to 400 inches of water. The test gage indicates the pressure being applied to the item under test.

DIFFERENTIAL PRESSURE GAGE.—The differential pressure gage (4) is a bellows-operated gage and is calibrated from 0 to 100 inches of water. The differential pressure gage indicates the changes in pressure. One side of the bellows is connected to the male quick disconnect protruding on the face of the stand. The other side of the bellows connects into the system pressure.

DIFFERENTIAL PRESSURE GAGE SHUTOFF VALVE.—The differential pressure gage shutoff valve (6) controls the flow of the system to one side of the gage. This valve must be on when using the differential pressure gage. The purpose of the valve is to protect the differential gage from damage when not in use.

FLOWMETERS.—The flowmeters are of the variable area glass tube type. Each flowmeter is individually mounted with a male quick disconnect fitting beneath each flow rater. There are two rate flowmeters (1) (high range) on the right side of the test stand. From left to right they are graduated to measure from 3 to 35 l.p.m. and 28 to 295 1.p.m. There are two leakage flowmeters (2) (low range) on the left side. They are graduated to measure from 0.003 to 0.05 1.p.m. and 0.04 to 0.46 l.p.m. The purpose of the flowmeters is to measure the amount of flow from the items under test.

BELL JAR ASSEMBLY.—The bell jar (11) is located on the counter of the stand. There is an internal connector located in the base of the jar. It is the female portion of the quick disconnect. The bell jar is used when testing components made of several joined pieces or fittings, where the possibility of several leaks exists. To prevent excessive pressure in the bell jar, a spring-loaded relief valve is incorportaed in the hose. The relief valve is set to relieve the pressure at 6 p.s.i.

ADAPTER FIXTURE.—The adapter fixture is located inside the cabinet below the bell jar. There is a relief valve set at 410 to 470 p.s.i. to relieve excessive pressure in the test stand system. The adapter fixture routes oxygen to the following components:

1. Female quick disconnect inside the bell jar or to the item under test.
2. Test pressure gage.
3. Differential pressure shutoff valve.
4. System bleed valve.

METALLIC FLEX HOSE.—There is a 24-inch metallic flex hose furnished with the test stand. The hose has female quick disconnects on both ends. It connects items under test or the bell jar directly to any flowmeter or to one side of the differential pressure gage.

PRESSURE REGULATOR.—The pressure regulator (10) is factory preset at 400 p.s.i. to protect the test gage. The regulator can be used if desired to regulate the pressure to the item under test. The pressure regulator regulates and routes oxygen to the supply oxygen valve.

SUPPLY OXYGEN VALVE.—The supply oxygen valve (8) is a needle type valve and admits pressure to the adapter fixture.

SYSTEM BLEED VALVE.—The system bleed valve (7) is also a needle type valve and is used to bleed pressure from the adapter fixture.

ADAPTER SET.—An adapter set is furnished with the test stand which contains all the necessary adapters and plugs for connecting components that are to be tested.

Types of Tests

Before commencing any test, check to see that the test pressure gage and the differential pressure gage are indicating zero. Keep in mind that specific operating pressures and flows must be taken from the overhaul manual for the particular item being tested.

FLOW TEST.—The flow test is checking an item that is required to pass a specified amount of flow. The procedure for flow testing a relief valve is as follows:

1. Connect the valve to the proper adapter, and connect the valve adapter to the quick disconnect fitting in the bell jar base.

2. Connect the valve directly to the appropriate rate flowmeter with the flex hose.

3. Slowly open the supply oxygen valve to the specified pressure as indicated on the test gage pressure.

4. Read the amount of flow on the flowmeter and compare with the specified amount of flow given for the valve.

5. Close the oxygen supply valve, open the system bleed valve, and remove the item from the test stand.

LEAK TEST.—The leak test is performed on items to check for leakage and to measure any slight amount of allowable leakage. Following is the procedure for checking the leakage on a filler valve:

1. Connect the valve to the proper adapter, and connect the valve adapter to the quick-disconnect fitting in the bell jar base.

2. Install the bell jar cover and connect the bell jar to the appropriate leakage flowmeter with the flex hose.

3. Slowly open the supply oxygen valve to the specified test pressure as indicated on the test pressure gage.

4. Read the amount of leakage, if any, on the leakage flowmeter.

5. Turn the oxygen off, bleed the system, and remove the valve.

PRESSURE TEST.—The pressure test is to check an item for pressure holding, or releasing characteristics. The procedure follows:

1. Connect the accessory to be tested to the proper adapter and connect the adapter to the quick disconnect in the bell jar base.

2. Open the supply oxygen valve to the specified test pressure and then close. Observe the test pressure gage for the required time and check for pressure drop.

3. Bleed the system and remove the item from the test stand.

DIFFERENTIAL PRESSURE TEST.—The differential pressure test is to determine the opening or closing pressures on the item to be checked. The procedure for checking a pressure control valve follows:

1. Connect the valve to the proper adapter and connect the adapter to the quick disconnect in the bell jar base.

2. Connect the flex hose from the valve to the male portion of the disconnect on the differential pressure gage.

3. Open the differential pressure gage shutoff valve by raising it to the vertical position.

4. Slowly open the supply oxygen valve to the specified closing pressure of the pressure closing valve.

5. Increase the pressure slowly and observe both the test pressure gage and the differential pressure gage.

6. Record the reading on the test pressure gage at the exact moment the differential pressure gage pointer jumps away from zero. This is the closing pressure of the valve.

7. Increase the oxygen pressure further and record the reading on the test pressure gage at the exact moment the differential pressure gage pointer moves back to zero. This is the opening pressure of the valve.

8. Close the supply oxygen valve, bleed the system, and remove the valve from the test stand.

Maintenance

LEAK TEST ON THE TEST STAND.—A leak test on the test stand is to be performed weekly in the following manner:

1. Cap the outlet ports on both leakage flowmeters.
2. Install the bell jar and connect it to one of the flowmeters, using the flex hose.
3. Open the differential pressure gage shutoff valve.
4. Slowly open the supply oxygen valve until the differential pressure gage indicates 100 inches of water pressure. Close the supply oxygen valve.
5. Wait 10 minutes and read the differential pressure gage. Maximum allowable drop is 2 inches of water pressure. If there is excessive leakage indicated, soap the bell jar base, flex hose connections, and flowmeters to determine the leak.
6. Connect the flex hose to the other flowmeter and repeat the test.
7. Open system bleed valve, close the differential pressure gage shutoff valve and remove the bell jar.
8. Plug the flex hose to the quick disconnect in the bell jar base and apply 400 p.s.i. oxygen pressure as indicated on the pressure gage. Wait 10 minutes and read the pressure gage. Maximum allowable drop is 5 p.s.i.

9. Open the system bleed valve.

ADJUSTING TEST PRESSURE GAGE.—The test pressure gage is checked daily to determine if the pointer is indicating zero. If the gage is not indicating zero, remove the cover from the back of the stand and turn the adjusting screw back of the gage until the gage is indicating zero.

ADJUSTING DIFFERENTIAL PRESSURE GAGE.—If the differential pressure is not indicating zero, loosen the screw in the base of the gage bezel, pull the bezel out slightly, and lift the assembly forward and away from the dial. Insert a screwdriver into the small access hole on the dial face and turn adjustment screw until the gage indicates zero.

ADJUSTING THE PRESSURE REGULATOR.—The pressure regulator is checked once a month. Loosen the hex nut on the pressure reducer and back the handle out. Plug the quick disconnect in the bell jar base. Open the oxygen supply fully and turn the pressure reducer until the pressure gage indicates 400 p.s.i. Tighten the hex nut which locks the handle.

CHECKING THE BELL JAR RELIEF VALVE.—Install the bell jar and connect the jar to the pressure gage calibrated in 1/2 p.s.i. graduations. Open supply oxygen valve slowly; when the pressure reaches 6 p.s.i., the relief valve should dump. If adjustment is necessary, remove the bell jar and either increase or decrease the pressure on the spring in the relief valve as required.

CALIBRATION OF FLOWMETERS AND GAGES.—The flowmeters and gages are checked once a month. Connect a master flowmeter or pressure gage to gage or flowmeter on the test stand that is being calibrated. Set the actual flows or pressures on the master gage or flowmeters. Record the indicated flows or pressures on the test stand gage or flowmeter. Make new correction cards if necessary.

QUIZ

1. The output flowmeter on an oxygen regulator test stand is used to measure
   a. air going through the regulator
   b. flow from the regulator
   c. oxygen going through the regulator
   d. flow to the regulator

2. The suction manometer (draft gage) on the 122C test stand is calibrated from ________________ inches of water pressure
   a. + 0.60 to - 1.60
   b. + 60 to - 0.160
   c. -2 to + 20
   d. - 10 to + 25

3. The pressure suction manometer is connected with the
   a. pressure top to the vacuum line
   b. pressure side to the regulator outlet
   c. pressure side connected to the chamber
   d. suction side connected to the chamber

4. The orifice supplied with the 122C test stand is used to
   a. check test stand leakage
   b. check regularity of flow through regulator
   c. time oxygen ratio
   d. check test stand calibration

5. The test stand handbook recommends a vacuum pump with a capacity of approximately
   a. 3 standard cubic feet per minute at 35,000 feet
   b. 6 standard cubic feet per minute at 35,000 feet
   c. 6 cubic feet per minute at 25,000 feet
   d. 6 cubic feet at 35,000 feet

6. On the C11250 test stand the pressure suction manometer is calibrated from ________________ inches of water pressure
   a. - 2 to + 20
   b. - 1.60 to + 60
   c. - 4 to + 20
   d. - 10 to + 25

7. To avert actuating the fluid from the pressure suction manometer into the chamber the C11250 test stand is equipped with a/an
   a. pressure bypass
   b. emergency pressure bypass
   c. suction bypass
   d. pinch tube

8. The OTS-565 test stand is calibrated in
   a. liters per minute
   b. inches of water pressure
   c. liters per minute and inches of water pressure
   d. none of the above

9. Flowmeters of the C11250 and 122C test stands are packed with
   a. glass wool
   b. baffles
   c. restrictors
   d. all of the above

10. When checking the calibration of a test stand the flowmeter readings should be within what percent of the calibration check card readings?
   a. 115
   b. 10
   c. 4
   d. 3-1/2

11. The low pressure gage on the OTS-565 test stand is calibrated from ________________ p.s.i.
   a. 0 to 200
   b. 0 to 175
   c. 50 to 200
   d. 50 to 175

12. The Vol-O-Flo measuring manometers on the OTS-565 test stand have a range of ________________ inches of water pressure
   a. 0 to 16
   b. 0 to 12
   c. 0 to 20
   d. - 4 to + 20

13. The pressure suction manometer in the OTS-565 test stand is designed to measure
   a. suction
   b. pressure
   c. suction and pressure
   d. none of the above

14. On the OTS-565 test stand system leakage test, what is the allowable leakage?
   a. 50 p.s.i. in 30 minutes
   b. 125 p.s.i. in 10 minutes
   c. 30 p.s.i. in 30 minutes
   d. 500 p.s.i. in 30 minutes

15. On the OTS-565 test stand what is the allowable leakage of the chamber, manometers and Vol-O-Flo elements?
    a. No leakage allowed
    b. 50 p.s.i. in 1 minute
    c. 100 feet in 5 minutes
    d. 100 feet per minute for 5 minutes
16. The test stand altimeter should be checked against a master altimeter
    a. quarterly
    b. semiannually
    c. yearly
    d. none of the above
17. On the OTS-565 the altitude actually used to test for chamber leakage is ________________ feet
    a. 50,000
    b. 40,000
    c. 30,000
    d. 35,000
18. The low pressure side of a canister is connected to the
    a. oxygen inlet
    b. chamber outlet
    c. flowmeter bottom
    d. flowmeter top
19. The input flowmeter measures
    a. flow of air drawn into the chamber
    b. flow from regulator outlet
    c. flow of air from chamber outlet
    d. all pressure and suction readings
20. The pressure side of a canister is connected to the
    a. bottom of suction manometer
    b. top of flowmeter
    c. bottom of flowmeter
    d. top of altimeter index
21. At what altitudes is the intercomparison test performed on the OTS-565?
    a. 5, 15, and 30 thousand feet
    b. 5, 10, and 30 thousand feet
    c. 10, 15, 20 thousand feet
    d. 10, 15, 30 thousand feet
22. On the OTS-565, output and input readings should compare within
    a. 1 l.p.m. or 1 percent
    b. 1 l.p.m. or 2 percent
    c. 2 l.p.m. or 1 percent
    d. 1 l.p.m. or 2 percent

23. What flows are used when performing the intercomparison test?
    a. 10, 50 and 80 l.p.m.
    b. 10, 40 and 60 l.p.m.
    c. 5, 40 and 85 l.p.m.
    d. 5, 50 and 85 l.p.m.

CHAPTER 5

TEST STAND RECALIBRATION

Oxygen regulator test stands require periodic recalibration. Test stand calibration must be checked DAILY to insure that the indicated flow readings for both the input and output flowmeters are within the specified values. These values are listed on a calibration check sheet, which is made up from input and output calibration charts. The calibration charts are secured to the test stand.

The daily check for calibration is performed after the test stand has been checked for inward leakage, and it is made with a standard orifice which is furnished with the test stand.

In making the daily check, if either input or output flowmeter reading fails to come within ±4 percent of the upper and lower values shown on the calibration check chart, the flowmeters must be recalibrated. If either flowmeter reading will not remain within the specified range, the canisters must be replaced.

Damaged fittings or dented canisters will change the linear resistance, and the defective canister, or possibly both canisters, must be replaced. This will also necessitate recalibration of the flowmeters.

The theory of calibrating a test stand is simply passing a known ACTUAL flow of air through the test stand canisters and recording the INDICATED readings from the flowmeters. The flowmeters are of the linear resistance type in which the pressure drop across a canister is the measure of the flow. This indicated flow or reading varies because no two canisters have the same linear resistance. This necessitates individual calibrating of each test stand flowmeter canister.

After a test stand has been recalibrated, output and input curve graphs are made. These graphs are used in converting actual flows to indicated flows.

On all tests required in checking a regulator, the flows given in the regulator manual are actual flows. These actual flows must be converted to indicated and corrected indicated flows before the performance of the regulator can be tested.

In this chapter a proposed method of calibrating test stand flowmeters with a field standard calibrator is given. In addition, a simple procedure for periodic checking of the OTS-565 test stand flowmeters for calibration is given.

The following handbooks contain additional data and instructions, and should be studied in conjunction with this chapter:

AN 17-15BC-505, *Handbook of Operation, Service, and Overhaul Instructions,* OTS-565 Test Stand.

AN 17-15BC-3, *Handbook of Operation, Service, and Overhaul Instructions,* Demand Oxygen Regulator Test Stand (OT-122C ARO).

NavAer 17-15BC-503, *Handbook of Operation and Service Instructions,* Demand Oxygen Regulator Test Stand (C11250 ARO).

AN 03-50A-48, *Handbook of Overhaul Instructions,* Automatic Positive Pressure Diluter Demand Oxygen Regulator (Eclipse-Pioneer).

TEST STAND FIELD CALIBRATOR

The test stand field calibrator (Part No. OTSC-100) is manufactured by National Instrument Laboratories. Figure 5-1 shows a front view of the unit; figure 5-2 is a rear view of the front panel.

Description

The calibrator is designed to calibrate oxygen test stands, diluter demand regulator type. By accurately measuring the flow of air through the calibrator into the test stand, the output and input flowmeters on the oxygen test stand may be calibrated.

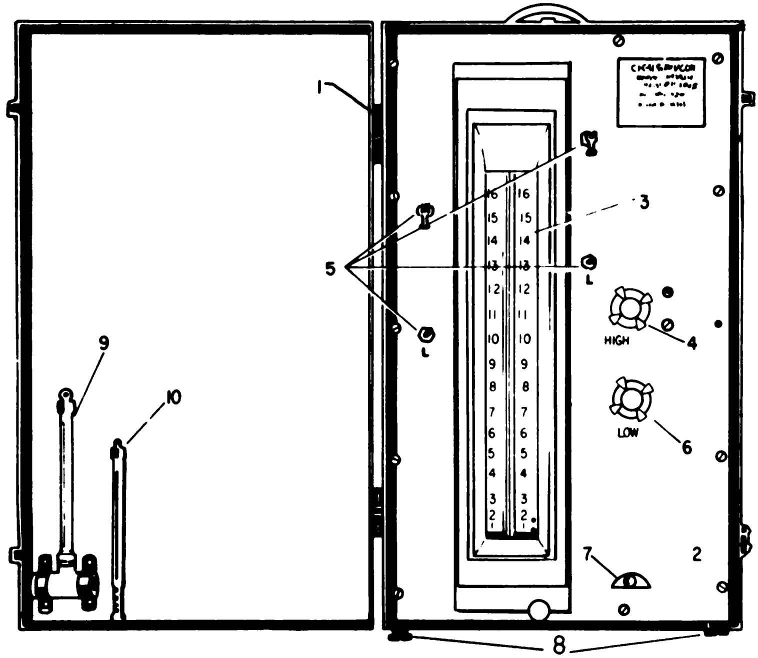


Figure 5-1.—Front view of test stand field calibrator (Part No. OTSC-100).

1. Case.
2. Panel.
3. Indicating manometer.
4. High flow cutoff valve.
5. Manometer valves.
6. Low flow cutoff valve.
7. Level.
8. Leveling legs.
9. Tee (air input with thermometer).
10. Test chamber thermometer.

The calibrator consists of a high flow Vol-O-Flo element covering the range of 0-160 l.p.m. and a low flow Vol-O-Flo element covering the range of 0-40 l.p.m. The Vol-O-Flo elements are piped in parallel with a cutoff valve on the downstream end of each Vol-O-Flo element. (See fig. 5-2.) The Vol-O-Flo elements are also piped to a 0-16 inch manometer with valving inserted in such a manner as to allow the use of either the high or low flow range. The manometer is protected by a check valve which prevents the manometer fluid from getting into the lines if the flow in either range is exceeded. A thermometer is mounted behind the panel to indicate air temperature at the input side of the Vol-O-Flo elements. Two additional thermometers are provided with the calibrator, one for measuring the temperature of the air going into the test stand and the second for measuring the temperature of the air within the evacuated chamber. A bubble lever is mounted on the front of the panel to facilitate the leveling of the calibrator.

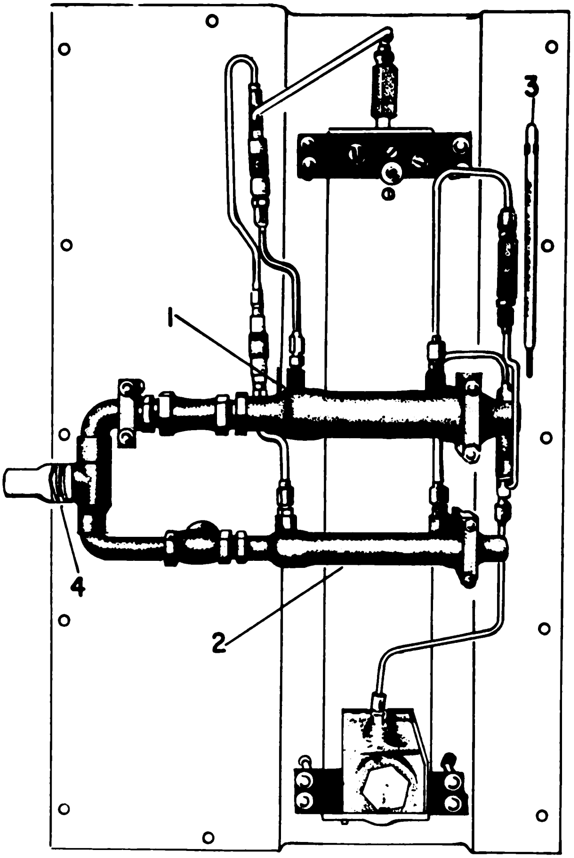


Figure 5-2.—Rear view of front panel.

1. High range Vol-O-Flo element.
2. Low range Vol-O-Flo element.
3. Thermometer.
4. Hose connection to oxygen test stand.
5. Check valve.

Preparation for Use, Storage, or Shipment

ASSEMBLY.—The test stand field calibrator is shipped complete in one unit. The following steps should be followed in setting up the calibrator:

1. Unpack the calibrator from its crate. Be sure that the manometer fluid is intact. Unlatch the front cover and remove the cover from its hinges. Make sure that the two thermometers attached to the front cover are intact.
2. Remove the screws attaching the panel to the case. The panel and the entire assembly can then be removed from the case.
3. To protect the glass manometer tube during shipment, cotton wads have been inserted between the scale and the glass tube. Do not attempt to move the scale adjustment knob in front of the manometer until this packing has been removed. To remove the cotton padding, first remove the scale positioning knob using an Allen head wrench. Then remove the four nuts holding the manometer panel to the main panel. The manometer panel can now be removed and the cotton padding taken out. Be careful not to smear the scale.
4. Replace the manometer panel and the scale adjustment knob. Position the scale so that it is near the center of its travel.
5. Remove the Allen head screw from the top of the manometer well. Hold the panel in a vertical position and fill the manometer well with the King blue oil supplied with the calibrator. The manometer should be filled to the approximate zero level, using a suitable funnel. Replace the Allen head screw, using a suitable thread sealer such as glyptal, care being observed to avoid contaminating the manometer fluid.
6. Check to see that all the manometer and Vol-O-Flo element tubing connections are tight. To check and tighten, be sure to use two wrenches.
7. Check the position of the thermometer mounted on the panel, making sure that the scale is facing the front.
8. Replace the panel assembly in the case and fasten in place with the screws provided.

9. Place the calibrator in the position where it will be used, with respect to the oxygen test stand.

10. Remove the thermometer tee from the calibrator cover and, using a short piece of hose, attach it to the air input in back of the test stand.

11. Attach a suitable hose of proper length to the thermometer tee and the calibrator output. The calibrator output is located on the right side under a latch cover.

12. Install hose clamps on all the hose ends to insure against leakage.

ADJUSTMENTS.—Before use, the calibrator and the connections to the test stand should be checked as follows:

1. With the calibrator in operating position, the four legs should be adjusted to level the calibrator, referring to the circular bubble on the panel. The four legs should then be secured by tightening the locknuts on each leg.

2. The second thermometer mounted in the calibrator cover should be removed and suspended in the oxygen test stand test chamber.

3. Adjust the calibrator manometer scale to zero. (The scale instead of the oil moves on the manometer.)

4. Plug the oxygen inlet to the test stand chamber with a suitable plug.

5. Close both the high and low flow valves on the calibrator.

6. With the air input valve open, evacuate the test stand to approximately 5,000 feet, using the bypass valve.

7. Close the bypass valve, wait a few minutes for temperature equalization, and check the leakage rate of the test stand by observing the altimeter. If this leakage rate is approximately the same as that of the test stand without the calibrator connected and the decrease is less than 100 feet per minute on the altimeter, then the equipment is satisfactorily leaktight and is ready for use. If the leakage rate is excessive, check the valve packing on the air input valve of the test stand.

STORAGE.—If the calibrator is to be stored for any length of time or is to be shipped to another location, the setup procedure should be followed in reverse. The manometer fluid should be drained. This is accomplished by removing the calibrator front panel and removing the large hexagonal-head screw located at the bottom of the manometer, directly below the glass tube. Using a short funnel, the oil should be drained into a clean bottle and the screw retightened.

Operation Instructions

The purpose of two Vol-O-Flo elements and the use of two flow ranges are to enable the operator to obtain more accuracy on the low flows. This is accomplished by manipulating the manometer cutoff valves of the calibrator, thus enabling the use of a single manometer for setting both the high and low flows.

To establish a flow of 0 to 40 l.p.m. through the field standard calibrator, the LOW valve is opened as wide as possible, and the manometer valves (L) are both opened. (See fig. 5-3.) The HIGH valve is closed, and the manometer valves (H) are both closed. When at altitude, the control of the flow through the calibrator into the test stand is obtained by using the air input valve on the test stand.

To establish a flow above 40 l.p.m., the HIGH valve should be opened as wide as possible, and the manometer valves (H) should be opened. (See fig. 5-4.) The LOW

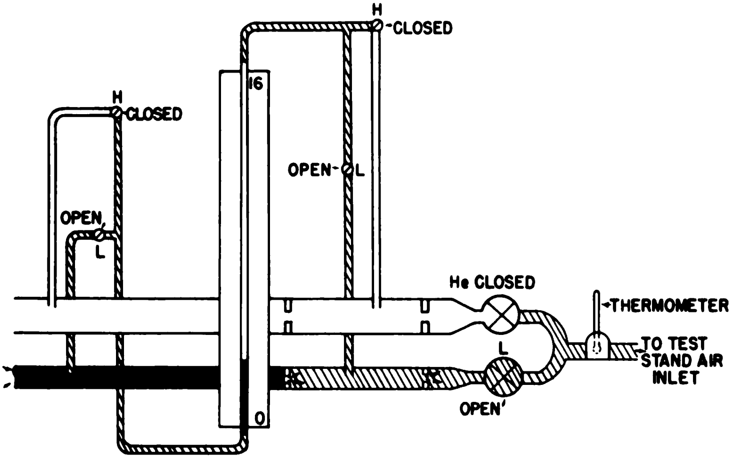


Figure 5-3.—Schematic diagram of low flow range.

valve is closed and the manometer valves (L) are both closed. Again, flow through the calibrator into the test stand is controlled at altitude by using the air input valve on the test stand.

Care should be taken when switching from low range to high range to prevent the possibility of blowing the manometer oil. The valves on the test stand should be closed before switching.

Computing Settings

The test stand field calibrator is calibrated in inches with a single manometer graduated from 0-16. The OT-122C (ARO) and the C11250 (ARO) test stands are calibrated in l.p.m. The various flows that are required to check the performance of the regulators are taken from the appropriate manual and are given in l.p.m. Since the flows to be set on the calibrator are in l.p.m. and must be set on the calibrator in inches, the l.p.m. flows must be converted to inches according to the proper HIGH or LOW range. This can be accomplished with a simple three-step formula and a worksheet. Once these manometer settings have been converted from l.p.m. to inches, they should be kept as a master copy for future reference.

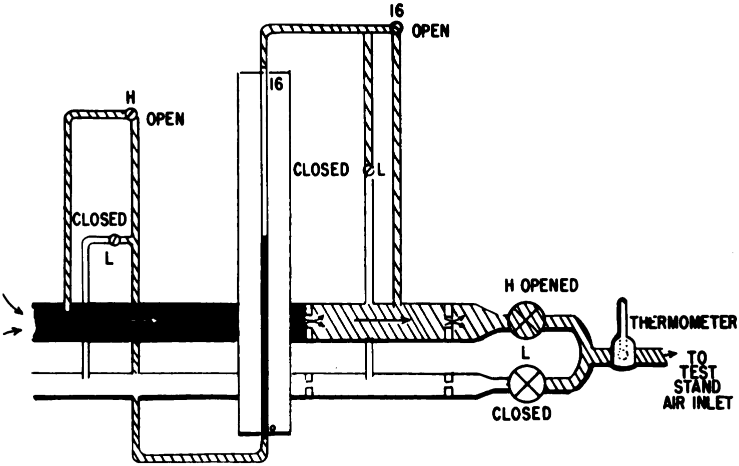


Figure 5-4.—Schematic diagram of high flow range.

The test stand flowmeters are calibrated with flows of 10, 30, 50, 70, 90, 110, 130, and 150 l.p.m. These flows are used at sea level and at altitudes of 5,000, 15,000, 25,000, 35,000, and 45,000 feet.

This worksheet can be set up to suit the individual. A proposed worksheet is shown in table 5-1. For the explanation of the symbols used in this three-step formula and also used on the worksheet, see table 5-2.

On the worksheet shown in table 5-1, the far left-hand column (Qa) is the actual flow at any altitude above sea level. The Qs column is the standard flow at 72° F. and 29.92 inches of mercury. The Qs is the first factor value to be found in the first step of the formula. The corrections supplied with the field calibrator are applied to each reading of the calibrator to give the correct flow at the inlet to the calibrator. The standard flow at 72° F. and 29.92 inches of mercury is attained by multiplying the field calibrator flow by the altitude factor. This altitude factor is the absolute pressure in inches of mercury at altitude. (See table 5-3.) As you will notice, at sea level the pressure inside the chamber is naturally the same as the pressure outside of the chamber.

In table 5-3, the applicable altitudes and the absolute pressures in inches of mercury have been underlined for your convenience.

The first step of the formula would appear as follows at sea level:

$$Qs = Qa \frac{Pa}{Po}$$

$$Qs = 10 \times \frac{29.92}{29.92}$$

$$Qs = 10 \times 1$$

$$Qs = 10$$

This will give the same figures in the Qs and Qa columns in the sea level block of the worksheet, inasmuch as the absolute pressure and the atmospheric pressure at sea level are the same.

As can be seen, there is nothing to the first step of the formula at sea level, so we will go through the complete three-step formula at altitude. For an example,

Table 5-1.—Worksheet, calibrator manometer settings.

Date ________ Calibrator No. ________ Operator ________

Sea level

Qa	Qs	Qr	M	Range
10 l.p.m.				
30 l.p.m.				
50 l.p.m.				
70 l.p.m.				
90 l.p.m.				
110 l.p.m.				
130 l.p.m.				
150 l.p.m.				

25,000 feet

Qa	Qs	Qr	M	Range
10 l.p.m.				
30 l.p.m.				
50 l.p.m.				
70 l.p.m.				
90 l.p.m.				
110 l.p.m.				
130 l.p.m.				
150 l.p.m.				

5,000 feet

Qa	Qs	Qr	M	Range
10 l.p.m.				
30 l.p.m.				
50 l.p.m.				
70 l.p.m.				
90 l.p.m.				
110 l.p.m.				
130 l.p.m.				
150 l.p.m.				

35,000 feet

Qa	Qs	Qr	M	Range
10 l.p.m.				
30 l.p.m.				
50 l.p.m.				
70 l.p.m.				
90 l.p.m.				
110 l.p.m.				
130 l.p.m.				
150 l.p.m.				

15,000 feet

Qa	Qs	Qr	M	Range
10 l.p.m.				
30 l.p.m.				
50 l.p.m.				
70 l.p.m.				
90 l.p.m.				
110 l.p.m.				
130 l.p.m.				
150 l.p.m.				

45,000 feet

Qa	Qs	Qr	M	Range
10 l.p.m.				
30 l.p.m.				
50 l.p.m.				
70 l.p.m.				
90 l.p.m.				
110 l.p.m.				
130 l.p.m.				
150 l.p.m.				

Table 5-2.—Formula and explanation of the symbols.

1. $Qs = Qa \frac{Pa}{Po}$

2. $Qr = Qs \pm Cf$

3. $M = \frac{Qr}{C}$

Explanation of symbols:

Qs — Standard flow at 72° F. and 29.92 inches of mercury.
Qa — Actual flow at any altitude above sea level.
Pa — Absolute pressure in inches of mercury at altitude.
Po — Standard barometric pressure, 29.92 inches of mercury.
Qr — Indicated flow.
Cf — Correction factor.
M — Manometer setting.
C -- Coefficient for calibrator Vol-O-Flo elements.

we will use the 5,000-foot altitude level. In table 5-3, the absolute pressure in inches of mercury at the various altitudes are given. At this time it is advisable to transcribe the applicable absolute pressures at the required altitudes in the upper right corner of the appropriate altitude block on the worksheet. This will eliminate any further reference to this particular table in regard to computing the settings for the calibrator.

The first step of the formula for the 5,000-foot altitude is computed as follows:

$$Qs = Qa \frac{Pa}{Po}$$

$$Qs = 10 \times \frac{24.89}{29.92}$$

$$Qs = 10 \times 0.832$$

$$Qs = 8.32$$

This 8.32 is entered for the 10 l.p.m. flow in the Qs column of the 5,000-foot altitude block on the worksheet. To carry this first step of the formula one flow higher, the 30 l.p.m. flow is computed as follows:

Table 5-3.—Altitude pressure table (condensed version from NACA Report No. 538).

Altitude	Pressure		Altitude	Pressure	
Feet	Inches (mercury)	Millimeters (mercury)	Feet	Inches (mercury)	Millimeters (mercury)
-1,000	31.02	787.9	600	29.28	743.7
- 900	30.91	785.1	700	29.17	741.0
- 800	30.80	782.2	800	29.07	738.3
- 700	30.69	779.4	900	28.96	735.6
- 600	30.58	776.6	1,000	28.86	732.9
- 500	30.47	773.8	5,000	24.89	632.3
- 400	30.36	771.1	10,000	20.58	522.6
- 300	30.25	768.3	15,000	16.88	428.8
- 200	30.14	765.5	20,000	13.75	349.1
- 100	30.03	762.8	25,000	11.10	281.9
0	29.92	760.0	30,000	8.88	225.6
100	29.81	757.3	35,000	7.04	178.7
200	29.71	754.5	40,000	5.54	140.7
300	29.60	751.8	45,000	4.36	110.8
400	29.49	749.1	50,000	3.43	87.3
500	29.38	746.4			

$$Qs = Qa \frac{Pa}{Po}$$

$$Qs = 30 \times \frac{24.89}{29.92}$$

$$Qs = 30 \times 0.832$$

$$Qs = 24.96$$

The altitude factor (absolute atmospheric pressure) for the 5,000-foot level, taken from the altitude pressure table, is 0.832 inches of mercury. This figure should be entered in the upper left-hand corner of the altitude block on the worksheet to be readily available for any future use.

This altitude factor is multiplied by each of the flows given for the field calibrator to determine the Qs, which is the standard flow at 72° F. and 29.92 inches of mercury. (See table 5-4.)

This completes the first step of the formula for one altitude. It should be completed for the sea level block and for each of the altitude blocks before proceeding to the next step of the formula.

Up to this point on the worksheet, the Qa and Qs figures will be the same, regardless of the field calibrator for which the settings are being computed.

To compute the Qr (indicated flow) settings, it is necessary to consult a calibration graph. Three copies of the calibration graphs are furnished with each calibrator.

Table 5-4.—Worksheet, 5,000-foot altitude block showing figures in the Qs column and proper range.

0.832				24.89
Qa	Qs	Qr	M	Range
10 l.p.m.	8.32			L
30 l.p.m.	24.96			L
50 l.p.m.	41.60			H
70 l.p.m.	56.24			H
90 l.p.m.	76.88			H
110 l.p.m.	98.53			H
130 l.p.m.	108.16			H
150 l.p.m.	124.80			H

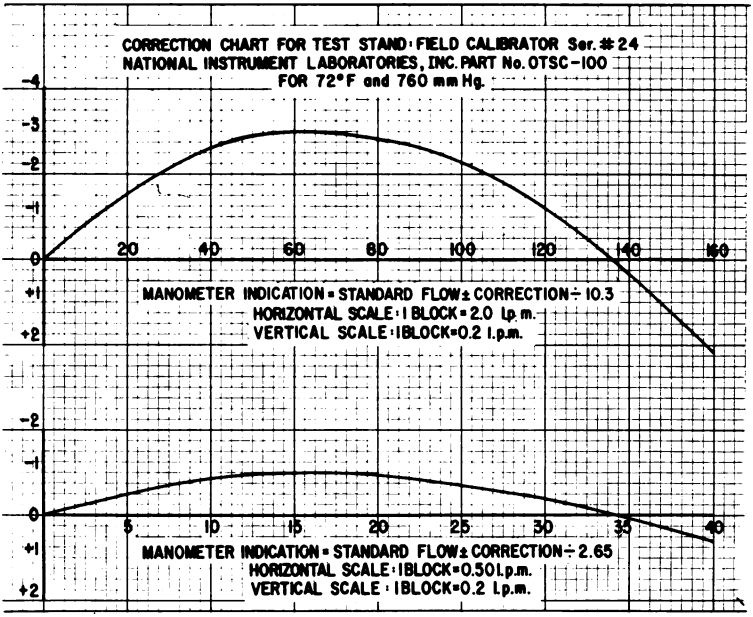


Figure 5-5.—Correction graph for field calibrator.

These graphs give the accurate volumetric flow through the calibrator Vol-O-Flo elements for both the 0-40 l.p.m. and the 0-160 l.p.m. ranges.

Before attempting to use the calibration graph in computing the Qr settings, it is necessary to determine in what range the flows are. This is done by the Qs flows. If the flow is 0-40 l.p.m., it is a LOW FLOW and the correction is made by using the lower curve on the graph. If the flow is over 40 l.p.m. (40.01), it is a HIGH FLOW and the upper curve is used. Keep in mind, once the range is determined and a correction is made using the correct curve on the graph, this range cannot change from a low to a high or a high to a low range. In a few instances on computing the worksheet, expecially at the higher altitudes, a Qs flow may be 40.70 l.p.m., which is a high range flow. Upon completing the second step of the formula you may get a 39.35 l.p.m. flow which appears to be a low range flow, but it is still a high range flow inasmuch as the Qs determines the range.

Another reason for keeping the flows in the proper range is that in the third step of the formula, the calibration graph is used to get the coefficient for the volumetric flow through the Vol-O-Flo element, and the HIGH or LOW range determines the correct curve to use on the graph. Lastly, it is important to keep the flow in the proper range because after the manometer settings are computed in the third step of the formula, all the flows will be in inches of mercury ranging from 0 to 16. This manometer setting is transcribed to another worksheet, which will be explained later in this chapter.

It is impossible to determine if the manometer setting should be set in the HIGH or LOW range on the calibrator if not so marked with the proper (H) or (L) to indicate the range. After all the Qs flows for all the altitude blocks are completed, it is advisable to label each flow (L) for 0-40 l.p.m., or (H) for 40-160 l.p.m. This is determined from the Qs flows in the column provided on each altitude block. This HIGH or LOW range indication can then be transcribed to the actual calibration worksheet along with the manometer setting. This will eliminate any possibility that a manometer setting will be set in the wrong range.

The second step of the formula is to determine the Qr (indicated flow) for the calibration and would appear as follows:

$$Qr = Qs \pm Cf$$

$$Qr = 8.32 \pm 0.57$$

$$Qr = 8.32 - 0.57$$

$$Qr = 7.75$$

The correction factor Cf can be found by a simple procedure of plotting on the calibration graph. (See fig. 5-5.) In this example we are still using the 5,000-foot altitude block. As shown in table 5-4, the first Qs flow at the 5,000-foot altitude is 8.32, which is a low range flow. Using the calibration graph shown in figure 5-5, project across the bottom of the lower graph to the right until 8.32 is reached. Project upward to the curve line, then read to the left to get the correction factor.

At this point in computing the settings for the calibrator, the settings will be slightly different for all calibrators. The Vol-O-Flo elements used in the calibrator are constructed with two orifices to create the required pressure drop. Since no two orifices can be made identical, the volumetric flow will be different for each Vol-O-Flo element.

In figure 5-5, the horizontal scale for the low flow curve differs from the horizontal scale for the high flow curve. On the low flow curve, each block equals 0.50 l.p.m., while on the high flow curve, each block equals 2.0 l.p.m. On the vertical scale of both the high and low flow curves, each block equals 2.0 l.p.m.

Care must be exercised in reading this graph since the scale is so small. The original graphs that come with each calibrator are scaled even smaller. Another reason why care and caution must be employed in reading the graph is that the example figure (8.32) does not fall on a line. To read the 8.32 l.p.m. on the horizontal scale, project to the 8.00 l.p.m line, then estimate the location of 8.32 l.p.m. (Remember that each block equals 0.50 l.p.m.) This may vary slightly with each individual but the variation is so small that there will be no noticeable difference on the final manometer setting. For this particular graph, the 8.32 l.p.m. is plotted to hit the curve line at approximately 0.57 l.p.m.

Observe that the flows across the bottom are l.p.m., and the figures up the left side are the l.p.m. correction factor (Cf). If the intersection of the l.p.m. flow and the curve is above the zero on the left side, subtract this correction factor from the Qs flow. This gives the Qr flow, which is the indicated flow. If the l.p.m. flow intersects the curve below the zero, add the correction factor to the Qs flow to give the Qr flow. NOTE: In figure 5-5, at approximately 35 l.p.m. on the horizontal scale, the curve drops below zero. Referring again to the formula, it would appear $Qr = Qs \pm 0.57$, or $Qr = 8.32 \pm 0.57$ in this example. Since the intersection of the curve is above the zero line, it is a minus, so it is subtracted from the Qs figure. This will leave 7.75 for the 10 l.p.m. flow in the Qr column on the 5,000-foot altitude block of the worksheet.

The next higher flow is 24.96 l.p.m., as shown in table 5-4. This is a low range flow and would appear as

$Qr = Qs \pm Cf$ or $Qr = 24.96 \pm 0.47$. The correction factor is 0.47, which is found by projecting horizontally to the 24.96 point and then up to the curve. It is still above the zero line, so the correction factor is subtracted from the 24.96. Therefore, $Qr = 24.96 - 0.47$ or $Qr = 24.49$. The Qr figures are entered in the column provided. (See table 5-5.) Keep in mind that the next higher flow, which is 41.60 l.p.m., changes from a low to a high range flow and the upper curve is used to find the correction factor.

Table 5-5.—Worksheet, 5,000-foot altitude block, showing figures in the Qs, Qr column and the proper range.

0.832		5,000 feet		24.89
Qa	Qs	Qr	M	Range
10 l.p.m.	8.32	7.75		L
30 l.p.m.	24.96	24.49		L
50 l.p.m.	41.60	39.00		H
70 l.p.m.	56.24	53.24		H
90 l.p.m.	76.88	74.01		H
110 l.p.m.	98.53	96.26		H
130 l.p.m.	108.16	106.33		H
150 l.p.m.	124.80	123.90		H

This second step of the formula should be completed for the sea level block and all altitude blocks before proceeding to the next and last step of the formula.

The third step of the formula should appear as:

$$M = \frac{Qr}{C}$$

$$M = \frac{7.75}{2.65}$$

$$M = 2.92$$

This is the manometer setting for the 10 l.p.m. flow at the 5,000-foot altitude. The C coefficient for the calibrator Vol-O-Flo element is found under the appropriate high or low curve line on the calibration graph (fig. 5-5), and this coefficient is divided into each of the Qr flows to give the M (manometer) settings. (See table 5-6.) Again, it is of utmost importance to keep the designated high and low ranges separate. Notice that there is a different coefficient for each of the high and low curves (2.65 for the low curve and 10.3 for the high curve, for this particular graph). When the Qs is used to determine the high or low range, and the correction factor is plotted from the appropriate curve, it is imperative that the coefficient of the same curve be used in the last step of the formula. The third step of the formula is completed for the sea level block and all of the altitude blocks on the worksheet.

Table 5-6.—Worksheet, 5,000-foot altitude block, showing figures in the Qs, Qr, M column and the proper range.

0.832	5,000 feet			
Qa	Qs	Qr	M	Range
10 l.p.m.	8.32	7.75	2.92	L
30 l.p.m.	24.96	24.49	9.24	L
50 l.p.m.	41.60	39.00	2.81	H
70 l.p.m.	56.24	53.24	5.16	H
90 l.p.m.	76.88	74.01	7.18	H
110 l.p.m.	98.53	96.26	9.34	H
130 l.p.m.	108.16	106.33	10.32	H
150 l.p.m.	124.80	123.90	12.03	H

CALIBRATION WORKSHEET.—Another worksheet, which is necessary for the actual calibrating of the test stand, can be made to suit the individual needs. Table 5-7 shows a proposed worksheet suitable for this purpose.

Now that the three-step formula has been completed, the only thing needed for the calibration are the flows, altitude, M (manometer) settings, and the high or low range. The Qs and Qr figures are of no further use, as they were just steps in arriving at the manometer settings; however, it is advisable to keep the worksheet as a master copy for reference in the event of any mathematical errors.

This calibration worksheet is divided into blocks, with each block representing one of the flows. Each block runs from sea level to the 45,000-foot altitude. From the

Table 5-7.—Calibration Worksheet.

Date ______________________ Test Stand Type & Number ____________

Calibrator No. ___________ Operator ____________________________

10 l.p.m.

Altitude	M	Range	OQr	IQr
S.L.				
5,000				
15,000				
25,000				
35,000				
45,000				

30 l.p.m.

Altitude	M	Range	OQr	IQr
S.L.				
5,000				
15,000				
25,000				
35,000				
45,000				

50 l.p.m.

Altitude	M	Range	OQr	IQr
S.L.				
5,000				
15,000				
25,000				
35,000				
45,000				

70 l.p.m.

Altitude	M	Range	OQr	IQr
S.L.				
5,000				
15,000				
25,000				
35,000				
45,000				

90 l.p.m.

Altitude	M	Range	OQr	IQr
S.L.				
5,000				
15,000				
25,000				
35,000				
45,000				

110 l.p.m.

Altitude	M	Range	OQr	IQr
S.L.				
5,000				
15,000				
25,000				
35,000				
45,000				

Table 5-7.—Calibration Worksheet—Continued.

130 l.p.m.

Altitude	M	Range	OQr	IQr
S.L.				
5,000				
15,000				
25,000				
35,000				
45,000				

150 l.p.m.

Altitude	M	Range	OQr	IQr
S.L.				
5,000				
15,000				
25,000				
35,000				
45,000				

CALIBRATION CHECK POINTS

Stand No. ____________ Orifice No. ____________ Suction ____________

Altitude	OQr	IQr

Table 5-8.—Worksheet, calibration, 10 l.p.m. flow.

10 l.p.m.

Altitude	M	Range	OQr	IQr
S.L.	3.51	L		
5,000	2.92	L		
15,000	1.97	L		
25,000	.91	L		
35,000	.81	L		
45,000	.51	L		

manometer setting worksheet (table 5-1), transcribe on the calibration worksheet (table 5-6) the manometer setting and the proper range in which it is to be set. This can be done by starting with the 10 l.p.m. block, and transcribing all the 10 l.p.m. manometer settings from sea level to 45,000 feet (table 5-8).

When filling out this worksheet, be very careful of reverse transpositions on both the settings and the range. Any reverse transpositions will give erroneous flowmeter readings when calibrating. Erroneous readings would cause the curve lines to touch or cross on the graph which is plotted upon completion of the calibration.

Calibrating the Test Stand Flowmeters

Both the oxygen test stand and the field standard calibrator are intended to be calibrated with dry air; however, the calibration of the test stand in the field may be performed with ambient air (air containing some water vapor) passing through both the calibrator and the test stand with negligible loss in accuracy.

Temperature corrections are necessary when calibrating test stand flowmeters by means of a field standard when the temperature of air flowing through the standard differs from the temperature of the air flowing through the test stand by more than 1° F. Normally, this should not be necessary; for with any reasonably constant room temperature, by permitting the field standard and test stand to remain in the same area a few hours before starting the calibration, and by waiting a few minutes before taking readings after each change of altitude in the chamber, the temperature of the air flowing through the two should be within this limit.

If it is necessary to perform a calibration when the temperature difference exceeds 1° F., the following correction would be applied:

If the mean temperature of the flow through the field standard is above the temperature of the flow through the altitude chamber, the final value of the computed true ambient flow through the chamber would be reduced by 0.34 percent for each degree Fahrenheit difference. Similarly, if the temperature of the flow through the field standard is below the temperature of the flow through the altitude chamber, the final value of computed true ambient flow through the chamber would be increased by 0.34 percent for each degree Fahrenheit difference.

Preferably, the relative humidity of the room air should be below 60 percent; however, the calibration can be performed at higher humidity readings, provided no moisture is condensing in the equipment.

The following is the procedure for calibrating regulator test stand flowmeters with the field calibrator at sea level:

1. Adjust the flowmeters to zero, and attach the hose from the calibrator to the outlet of the test stand. NOTE: Only on calibrating at sea level is the hose connected to the outlet of the test stand. The test stand is calibrated with air but there is no air input at sea level, so in order to obtain a flow, the calibrator is connected to the vacuum source (test stand outlet).

On the modified OT-122C (ARO) test stand, it is necessary to disconnect the hose at the top (pressure side) of the pressure-suction manometer. Otherwise, a direct vacuum is applied when the calibrator hose is connected to the oxygen test stand outlet, causing excessive suction on the manometer. This overloads the latitude of the manometer, causing the fluid to be drawn into the lines. This also applies to the draft gage type suction manometer of the OT-122C (ARO) test stand if it has not been modified. The cutoff valves on the suction manometer must be closed.

This does not apply to the newer type C11250 (ARO) test stand as it has an emergency pressure release incorporated. It is necessary to have this emergency pressure release disengaged, so that the pressure and suction on the manometer will be equalized.

2. Open the low range flow cutoff valve on the calibrator, and open both low flow manometer valves. (See fig. 5-3.)

3. Using the worksheet (table 5-7), set the first desired low flow manometer setting by opening the outlet valve on the test stand. NOTE: Only on calibrating at sea level is the manometer setting set with the outlet valve, because the flow is set with outlet air (vacuum) instead of input air.

4. Record the output flowmeter reading in the OQr column provided on the worksheet (table 5-7).

5. Repeat step 3 and 4 for the remaining low range flows.

6. Close the test stand outlet valve.

7. Close the low range flow cutoff valve and both the low range manometer valves on the calibrator.

8. Open the high range flow cutoff valve on the calibrator fully and open both the high range manometer valves. (See fig. 5-4.)

9. Set the first desired high flow manometer setting using the outlet valve.

10. Record the output flowmeter l.p.m. reading in the OQr column on the worksheet.

11. Repeat steps 9 and 10 for the remaining high range flows.

12. Close the test stand outlet valve.

13. Close the high range flow cutoff valve and both the high range manometer valves on the calibrator.

14. Disconnect the hose from the outlet in the chamber of the test stand.

NOTE: There will be no input flowmeter readings on calibration at sea level.

The following is a procedure for calibrating the regulator test stand flowmeters with the field calibrator at altitude:

1. The outlet of the field calibrator is connected to the air inlet at the back of the test stand, using a tee inserted between the two, and a thermometer installed in the tee to read the air temperature. The second thermometer is installed on the panel at the inlet of the Vol-O-Flo elements of the calibrator, and the third thermometer is suspended in the altitude chamber. The high pressure oxygen line into the chamber of the test stand is plugged.

2. Open the low range flow cutoff valve and both of the low range manometer valves. NOTE: It makes no difference which range (either high or low) is used first in calibrating, but it will simplify the procedure if all of one of the ranges are set at one time to eliminate excessive manipulation of the cutoff valves and the manometer valves.

Calibrating for all flows at the same altitude is faster, even though it involves switching from high to low flows and vice versa. Care must be exercised to prevent blowing the oil from the manometer.

3. Place glass over the chamber, open outlet valve, and ascend to the first desired calibration altitude.

4. Open the inlet valve to obtain the first manometer setting for the first low flow.

5. Adjust the outlet valve, balancing the input and output to hold the calibration altitude constant.

6. Record the test stand output (OQr) and input (IQr) flowmeter readings in the appropriate columns of the worksheet (table 5-7).

7. Adjust inlet valve to obtain the next desired manometer setting.

8. Adjust the outlet valve, balancing the input and output to hold the calibration altitude constant.

9. Record the test stand output (OQr) and input (IQr) flowmeter readings in the appropriate columns of the worksheet.

10. Repeat steps 4 through 8 for all the low range flows at the remaining calibration altitudes.

11. After completing all the low flows up to the highest calibration altitudes, close outlet and inlet valves completely. If there is no test stand inward leakage, the altimeter will remain constant at this altitude. Close the low range flow cutoff valve and both of the low range manometer valves. Open the high range flow cutoff valve and both of the high range flow manometer valves.

12. Open the inlet valve to obtain the proper manometer setting for the first high range flow.

13. Adjust the outlet valve, balancing input and output to hold the calibration altitude constant.

14. Record the test stand output (OQr) and input (IQr) flowmeter readings in the appropriate columns on the worksheet.

15. Repeat steps 12 through 14 for the remaining high flows at highest calibration altitudes.

16. Descend to next lower calibration altitude and repeat steps 12 through 14 for all high flows.

17. Repeat step 16 for all the remaining calibration altitudes.

18. Disconnect the calibrator from the test stand.

19. Reconnect the pressure-suction manometer on the 122-C test stand.

While calibrating, the flows in both the OQr and IQr columns must decrease as the altitude increases. If, in either OQr or IQr columns, the flow does not decrease as the altitude increases, that manometer setting should be rerun. If the flow still does not decrease, that particular flow should be computed again through the complete three-step formula, as there is probably a mathematical error. If this is allowed to remain uncorrected, the altitude line will cross when the calibration curve graphs are plotted.

Making Calibration Check Point Chart

At the bottom of the worksheet (table 5-7), a block is provided for the calibration check points. These values are determined immediately upon completing the calibration of the test stand. With the test stand field calibrator disconnected, this is accomplished with a standard orifice furnished with the test stand.

The suction and altitude required for each of the ARO test stands are listed in table 5-9.

Table 5-9.—Suction and altitude required for calibration check.

OT-122C (ARO)	Suction 1.6"
Sea Level	20,000 Feet
10,000 Feet	30,000 Feet
C11250 (ARO)	Suction 1.0"
Sea Level	
15,000 Feet	30,000 Feet
20,000 Feet	35,000 Feet
25,000 Feet	40,000 Feet

The procedure for making the calibration check points follows:

1. Plug the oxygen inlet.
2. Install the correct orifice furnished with the test stand. If the orifice furnished with the test stand has been misplaced, any orifice can be used as long as subsequent calibration checks are make with the same orifice.
3. At sea level, open the outlet valve slowly and set the required suction on the pressure-suction manometer

for the test stand being used. (See table 5-9.) The restriction of the orifice, in contrast to the regular chamber outlet, creates the suction when the flow is applied.

4. Read the output flowmeter and record the l.p.m. flow in the column provided (OQr) at the bottom of the worksheet. There is no input flow at sea level.

5. Place glass cover over the chamber and ascend to the first test altitude by slowly opening the outlet valve. Stabilize the altimeter with the inlet valve until the correct altitude is steady. By manipulating both output and input valves, set the applicable suction, being sure to keep altitude steady.

6. Read both the output (OQr) and input (IQr) flowmeters and record the l.p.m. flows in the proper columns.

7. Ascend to the next higher test altitude and repeat steps 5 and 6.

8. After all test altitudes have been completed, descend to sea level by closing the outlet valve. This allows the outside ambient atmospheric pressure, which is greater than the pressure inside the chamber at altitude, to flow into the chamber, thus equalizing the pressure inside and outside the test stand chamber.

There is an allowable tolerance of 4 percent on the calibration of the test stand. This is referred to as the high and low allowable tolerance of the flowmeters. The high and low tolerance values are found by multiplying each output and input reading by 0.04. Add this result to the reading to obtain the high calibration limit. Subtract this result from the reading to obtain the low calibration limit. These high and low calibration limits should be placed on a small card and secured to the front of the test stand. (See table 5-10.) This will simplify the daily calibration check, as the high and low limits will be easily visible.

To prevent having to recalibrate the test stand due to loss of this card, a copy of this chart should be placed on either the output calibration curve graph, or the input calibration curve graph as a permanent record for as long as the test stand remains in calibration.

Plotting Calibration Graphs

To save time and for the convenience of the operator, a calibration graph for each output and input flowmeter

Table 5-10.—Calibration check point chart.

(OT-122C ARO)

Orifice No. ________ Suction 1.6"

Altitude	Output		Input	
	High	Low	High	Low
Sea Level				
10,000				
20,000				
30,000				

(C11250 ARO)

Orifice No. ________ Suction 1.0"

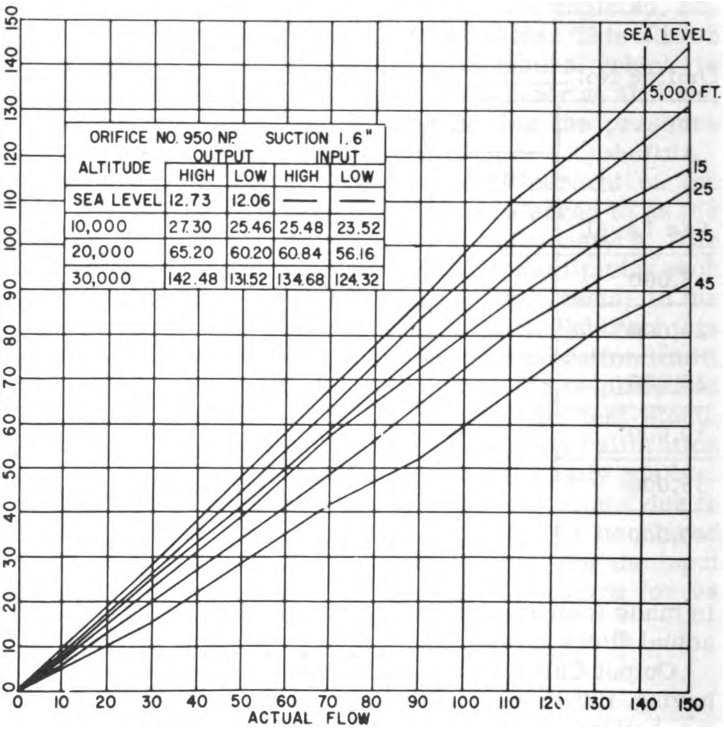
Altitude	Output		Input	
	High	Low	High	Low
Sea Level				
15,000				
20,000				
25,000				
30,000				
35,000				
40,000				

is made instead of referring to the worksheet to convert actual flows given in the manual to indicated flows.

Output Calibration Graphs are plotted on graph paper having 100 blocks to the square inch. Number across the bottom of the graph from 0 to 150 l.p.m., in increments of 10 l.p.m. This will be ACTUAL liters per minute (Qa). Number up the left side of the graph paper from 0 to 150 l.p.m., in increments of 10 l.p.m. This will be INDICATED liters per minute.

Using the worksheet (table 5-7), find the actual l.p.m. (Qa) for the first flow at sea level (10 l.p.m.) on the bottom of the graph. Read up from this point to the indicated l.p.m. (OQr) found on the worksheet. Make a dot where the two lines intersect. Repeat this procedure for all the remaining flows at sea level.

Using a straightedge; connect the dots. This will be labeled the sea level curve. (See fig. 5-6.) Repeat this procedure for all the remaining altitudes, connecting the dots for each line. NOTE: It is necessary that the same actual flow decrease as it intersects each altitude line. The atmospheric pressure decreases as altitude increases.



ORIFICE NO. 950 NP SUCTION 1.6"

ALTITUDE	OUTPUT		INPUT	
	HIGH	LOW	HIGH	LOW
SEA LEVEL	12.73	12.06	—	—
10,000	27.30	25.46	25.48	23.52
20,000	65.20	60.20	60.84	56.16
30,000	142.48	131.52	134.68	124.32

Figure 5-6.—Output Calibration Graph.

Input Calibration Graphs are plotted on the same kind of graph paper and numbered the same as the output graph. There will be no sea level curve line on the input graph. Find the actual l.p.m. (Qa) for the first flow at the 5,000-foot altitude on the bottom of the graph and read up to the indicated input l.p.m. (IQr) shown on the worksheet. Make a dot where the two lines intersect.

Repeat this procedure for the remaining flows at the 5,000-foot altitude, connect the dots with a line, and label it the 5,000-foot curve.

Repeat this procedure for all the remaining input flows for each altitude, connecting the dots and labeling each curve with the proper altitudes.

For easier reading of the graphs, a different colored pencil can be used for each altitude curve, as there is less possibility of accidentally jumping to a different altitude curve by reading up to a colored line. The combination of colors used are not important, but for consistency, it is advisable to use the same color for the same altitude curve on each output and input graph.

AIR-OXYGEN CONVERSION GRAPH.—Since the output flowmeter is used to measure the flow of mixtures of air and oxygen as well as air, a correction must be applied to the indicated reading in order to get an accurate measure of a particular mixture. For linear type flowmeters (such as glass wool canisters and concentric tubes currently used on test stands), the indicated reading will be 11.5 percent higher for oxygen than for the same flow of air. This is due to the difference in viscosity and density of the two gases.

Rather than compute this difference for each flow, it is more convenient to construct a graph that will give the flowmeter readings for various mixtures of air and oxygen as a function of indicated air readings.

This is done by drawing a graph divided to correspond to flowmeter markings. The horizontal scale represents manometer (indicated) readings for airflows, and the vertical scale represents manometer (corrected indicated) readings for air-oxygen mixture flows. (See fig. 5-7.) If, for example, the test stand flowmeters have scale reading from 0-150 or 160, then the scales on the graph are similarly subdivided.

A straight line drawn from origin (0) through the point on the graph corresponding to the 150 liters per minute reading on both scales represents the curve for 0 percent added oxygen or 100 percent air. Curves for other percentages of added oxygen may similarly be obtained by drawing straight lines from the origin through the following points:

Added Oxygen (percentage)	Horizontal Scale Airflow Reading (liters per minute)	Vertical Scale Mixture Flow Reading (liters per minute)
0	150	150.00
20	150	153.45
40	150	156.90
60	150	160.35
80	150	163.80
100	150	167.25

Temperature Considerations

On the linear type flowmeter the reading for a given flow is dependent on the gas (air, oxygen, or mixture), pressure (altitude), and temperature. The flowmeters are usually calibrated at a specified temperature near 72° F. If the test stand is operated in the temperature range 65° F. to 80° F. temperature corrections may usually be neglected.

If greater accuracy is required or if the test stand is used at temperatures outside this temperature range, a temperature correction may be applied as follows:

Determine the temperature for which the test stand was calibrated. If the test stand was calibrated against a field standard, the temperature of calibration is that for which the field standard correction curves were made. For each degree Fahrenheit the test stand is operating above the calibration temperature, the reading will be too high by 0.15 percent of the reading. For each degree Fahrenheit below the calibration temperature, the flowmeter reading will be 0.15 percent too low. These temperature corrections are in addition to and independent of corrections for altitude or gas mixtures.

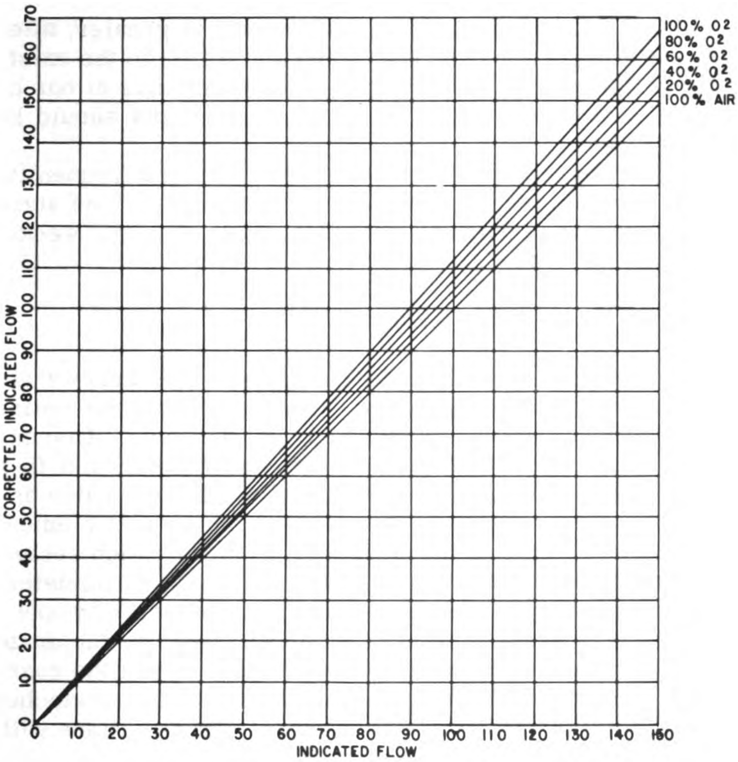


Figure 5-7.—Air-Oxygen Conversion Graph.

Flowmeter Checking Procedure

Of the various applicable methods of checking the flowmeters on a test stand, a simple method is recommended for the OTS-565 test stand. It consists of comparing the indications of the inlet and outlet flowmeters. This may be done by plugging the oxygen line to the chamber, closing the bypass valve, placing the glass cover over the chamber, and balancing the airflow through the inlet and outlet valves to maintain simulated pressure altitudes of 5,000, 15,000, and 30,000 feet. At each of these altitudes, nominal ambient flows of 5, 50, and 85 l.p.m. are established and the outlet and inlet flowmeters are read simultaneously.

The corrected output and input flows should agree to within 2 percent or 1 l.p.m., whichever is greater, after the readings have been corrected according to the existing calibrations. If they differ more than this at one or more test points, the test stand flowmeters should be recalibrated.

This intercomparison should be performed frequently, for example, every two weeks, or before use of the stand if it is not used during a period greater than two weeks.

Maintenance

MANOMETER CLEANING.—Remove the screws attaching the panel to the case. The panel and the entire assembly can now be removed from the case. Disconnect the copper tubing from the manometer and flow elements. Carefully remove the flow element valve assembly after removing the valve handles and element standoffs. Remove the nuts and washers which secure the manometer to the front panel. Remove the manometer.

Preparatory to cleaning, drain the manometer by opening the plug at the bottom of the case. Remove the drain plug and the overflow check valve at the top of the case. Pass a cylindrical tube cleaning brush soaked in alcohol completely through the tube several times. Rinse with clean alcohol and blow the tube dry using very dry air or gas.

If dry gas is not available, permit the tube to air-dry naturally. Do not wipe the inside of the tube, or blow it out with your breath. The flow check valve should be soaked in alcohol until all dirt and particles are removed. The well can be cleaned with a brush soaked in alcohol after removing the large cleanout plug on the back of the well. Rinse the well with clean alcohol and dry as above. Reassemble the manometer and replace on panel. Refill with King blue oil.

FLOW ELEMENTS.—The Vol-O-Flo elements may need to be cleaned but should not require recalibration in the field. If for any reason the calibration of the flowmeters is questionable, arrangements for laboratory calibration or overhaul should be made through the Bureau of Aeronautics.

Assembly Parts List

	Part Number	Quantity Required
OTSC-100	Field Calibrator	1
OTSC-100-1	Cabinet	1
-1A	Cover	1
-1B	Panel	1
-1C	Leveling Legs	4
OTSC-100-2	High Flow Flowmeter Vol-O-Flo 16A-160	1
-3	Low Flow Flowmeter Vol-O-Flo 16-A-40	1
-4	High Flow Valve 1/2" Lunkenheimer #2140	1
-5	Low Flow Valve 3/8" Lunkenheimer #906	1
-6	Manometer Model AB-FF, 0-16"	1
-7	Manometer Check Valve E-3685	1
-8	Manometer Valves-Hoke P-451	4
-9	Thermometer, Panel Modified Taylor Model 21518G	1
-10	Thermometer, Air input with "T"	1
-11	Thermometer, Chamber	1
-12	Level, Bubble Model 12-000	1

QUIZ

1. Input and output readings on test stand C11250 (ARO) must come within what percent of lower and upper values on calibration check chart?
   a. ±1
   b. ±2
   c. ±3
   d. ±4
2. On the field test stand calibrator OTSC-100, the high flow Vol-O-Flo element has a range of______l.p.m.
   a. 0 to 40
   b. 0 to 80
   c. 0 to 120
   d. 0 to 160

3. On the field test stand calibrator OTSC-100, the low flow Vol-O-Flo element has a range of______l.p.m.
    a. 0 to 40
    b. 0 to 80
    c. 0 to 100
    d. 0 to 120
4. The indicating manometer on the field test stand calibrator OTSC-100 has a range of______inches of water pressure.
    a. 0 to 12
    b. 0 to 14
    c. 0 to 16
    d. 0 to 18
5. At what altitude is the field test stand calibrator checked for leakage?
    a. 3,000 feet
    b. 5,000 feet
    c. 7,000 feet
    d. 9,000 feet
6. When using the field test stand calibrator at altitude, control of the flow through the calibrator and into the test stand is obtained by using the valve
    a. output
    b. bypass
    c. input
    d. pressure suction bypass
7. What altitudes are used when calibrating?
    a. 5, 15, 20, 25, and 35 thousand feet
    b. 5, 10, 25, 35, and 45 thousand feet
    c. 5, 15, 25, 35, and 45 thousand feet
    d. 5, 15, 20, 30, and 40 thousand feet
8. Before calibrating, the altimeter must be set to______ inches of mercury.
    a. 29.91
    b. 29.92
    c. 29.94
    d. 29.96
9. How much suction is drawn while performing the calibration check on the OT-122C?
    a. 1.0 inch
    b. 1.2 inches
    c. 1.4 inches
    d. 1.6 inches
10. How much suction is drawn while performing the calibration check on the OTS-C11250?
    a. 1.0 inch
    b. 1.2 inches
    c. 1.4 inches
    d. 1.6 inches

11. At what altitudes is the calibration check on the OTS-C11250 pulled?
    a. S/L, 10, 20, 30, 40, 45, 50 thousand feet
    b. S/L, 10, 25, 35, 45, 50, 55 thousand feet
    c. S/L, 15, 25, 35, 45, 50, 55 thousand feet
    d. S/L, 15, 20, 25, 30, 35, and 40 thousand feet

12. At what altitudes is the calibration check pulled on the OT-122C?
    a. S/L, 5, 15, 20 thousand feet
    b. S/L, 10, 20, 30 thousand feet
    c. S/L, 15, 25, 35 thousand feet
    d. S/L, 20, 30, 40 thousand feet

13. How much inlet pressure in p.s.i. is used when pulling the calibration check?
    a. 100
    b. 75
    c. 50
    d. 0

14. How many altitude lines are found on the output graph?
    a. 7
    b. 6
    c. 5
    d. 4

15. How much heavier than air is 100 percent oxygen?
    a. 9.5 percent
    b. 10.5 percent
    c. 11.5 percent
    d. 12.5 percent

16. What kind of oil is used in the OTSC-100?
    a. King blue oil
    b. King red oil
    c. Knight blue oil
    d. Knight red oil

17. The allowable leakage for the field test stand calibrator is less than______feet per minute.
    a. 500
    b. 400
    c. 200
    d. 100

18. When calibrating at sea level, the calibrator hose is connected to the
    a. air intake
    b. pressure suction manometer
    c. outlet of chamber
    d. input flowmeter

19. When calibrating at altitude, the field test stand calibrator hose is connected to the
    a. air intake
    b. pressure suction manometer
    c. outlet of chamber
    d. input flowmeter
20. The symbol Qa in the formula means
    a. correction factor
    b. standard flow at any altitude
    c. actual flow at any altitude above sea level
    d. indicated flow
21. When using the three-step formula, a flow of 40.01 would be considered a
    a. very high flow
    b. high flow
    c. low flow
    d. very low flow
22. When calibrating, why is there no input flow at sea level?
    a. Pressure is different between the inside and outside of chamber
    b. Pressure is the same between the inside and outside of chamber
    c. Pressure is increased on bottom of input flowmeter .
    d. Pressure is reduced on top of input flowmeter

CHAPTER 6

REGULATOR MAINTENANCE

Oxygen regulator maintenance was formerly performed only by O&R establishments; however, fleet activities are now authorized to perform a number of specific repairs at the class C maintenance level. This work is normally performed at fleet service units by PR1's and PRC's.

Although it is not always necessary to completely disassemble a regulator to make the necessary repairs, this chapter and the next chapter cover the disassembly and reassembly of the various types of regulators now being used by the Navy, and describe the recommended methods of determining and remedying malfunctions. The first section of this chapter discusses some of the problems involved in establishing and organizing a regulator repair shop.

REGULATOR REPAIR SHOP

Space Reqirements

Adequate space for the installation of all necessary equipment must be available before undertaking the maintenance of oxygen regulators. Approximately 600 square feet of floor space is the minimum requirement for the establishment of a combined oxygen and carbon dioxide shop. This size shop is suitable for the support of approximately 200 aircraft. More space should be provided where larger numbers of aircraft are serviced, and separate rooms for the various shop functions are also desirable. In addition, a loading ramp for the handling of oxygen storage cylinders should be provided.

Equipment Requirements

The following basic equipment is required:

Oxygen recharge equipment, demand oxygen regulator test stand, vacuum pump, oxygen water vapor indicator, Halide detector, oxygen recharge trailer, carbon dioxide recharge equipment, Detecto scale.

In addition to the above listed basic equipment, the following should be provided:

Oxygen storage cylinder tilt rack, carbon dioxide cylinder tilt rack, 3 workbenches, carbon dioxide detection equipment, rotary storage bin, oxygen cylinder storage bin, machinist's vise, and the necessary hand tools. Special tools are listed in the applicable sections of each chapter.

Shop Organization

Once the space and equipment requirements have been met, it is important to arrange the equipment in order to provide for its efficient use. Any functional organization should be designed to eliminate unnecessary movement and handling of oxygen cylinders. Equipment should be so located that supply cylinders may be moved from one apparatus to another in the logical sequence of their tests without interfering in any way with the other functions of the oxygen shop. For example, it is advantageous to have the supply cylinder tilt rack adjacent to the door of the shop. A bench located near the tilt rack for the oxygen water vapor indicator, Halide detector, and carbon dioxide detector allows for vapor and purity tests to be performed on incoming oxygen cylinders without moving them a second time. The cylinders then are moved to the nearby oxygen recharge equipment. This unit should be located so that exhausted cylinders can be removed from the shop easily.

It is advisable to separate the carbon dioxide recharge equipment from the oxygen section of the shop when practicable. The weight scale, cylinder vise, and transfer unit should be mounted on a sturdy workbench; and it is well to provide space at one end of the bench for the carbon dioxide supply cylinder tilt rack. There should also be plenty of ventilation in the vicinity of this section. If possible, the carbon dioxide equipment should be situated near a window in order that cylinder charging may be vented to the outside.

Segregation of all equipment relating to oxygen regulators is highly desirable, either by partitioning the shop or grouping this material in a separate section. This section should also be in a dirt- and dust-free area. The vacuum pump may be located in this area, under the bench supporting the regulator test stand. In addition, a regulator workbench and adjacent storage space should be provided. Personnel working in this segregated area would be undisturbed and would be in a position to use the equipment with maximum effectiveness.

DILUTER DEMAND OXYGEN REGULATOR (2858 SERIES)

Diluter demand oxygen regulators (Pioneer type) models 2858-A1, 2858-A1A, 2858-B1, and 2858-C1 are manufactured by Eclipse-Pioneer Division of Bendix Aviation Corporation, Teterboro, New Jersey. They are designed to be operated on an input pressure of 1,800 p.s.i. and to give diluted (or 100 percent) oxygen upon demand (inhalation) up to a service ceiling of 37,500 feet. This ceiling can be exceeded by 2,000 feet during emergencies for short periods of time only. These regulators are suction-diaphragm operated. They automatically mix varying quantities of air and oxygen, the ratio depending upon the altitude, and deliver the quantity demanded upon inhalation. Figure 6-1 is a three-quarter view of the 2858-A1 model.

Except for a few minor modifications, the 2858 series regulators are of the same basic design. Also, the disassembly, repair, and reassembly of these regulators are primarily the same. In this section the description of each component is followed by the removal and disassembly procedures. Following complete disassembly of the regulator, instructions for cleaning, inspecting reassembling, and testing are given.

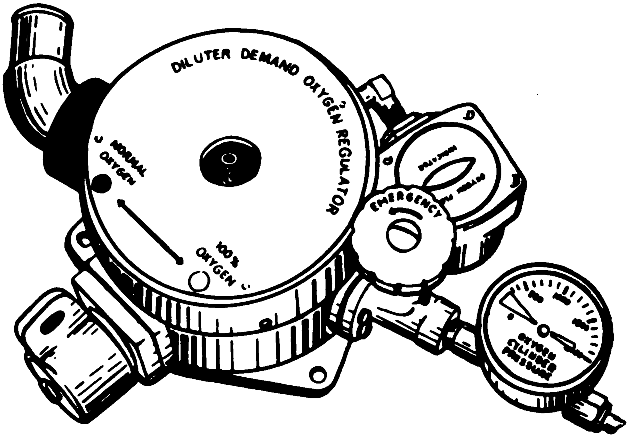


Figure 6-1.—Diluter demand oxygen regulator, model 2858-A1.

Emergency Valve Assembly

The regulator has an independent oxygen emergency valve. When the red emergency knob is turned counterclockwise, a large continuous stream of oxygen is allowed to bypass the entire regulator mechanism and enter the elbow. A directional arrow indicates the ON and OFF positions of the knob. For emphasis, the directional arrow is marked with luminous or radium paint.

REMOVAL OF THE EMERGENCY VALVE ASSEMBLY.—Removal of the emergency valve assembly is the first step in the disassembly of this type regulator. Referring to figure 6-2, first remove the shipping plug (4), if provided. Remove the screw (12) and shakeproof washer (11), slide the emergency valve knob (10) off the emergency valve shaft. Care must be used when removing the knob to avoid damaging the knurls. Take out the two screws (7) and lockwashers (8) and remove the emergency valve stop (9). Take out the four screws (3) and lockwashers (2) and carefully separate the emergency valve assembly (1) from the case. Care must be used to avoid dropping the inlet valve and insert assembly (13) which rests inside the emergency valve assembly. Remove the oxygen inlet gasket (16). Lift the inlet valve and insert assembly (13) out of the emergency valve

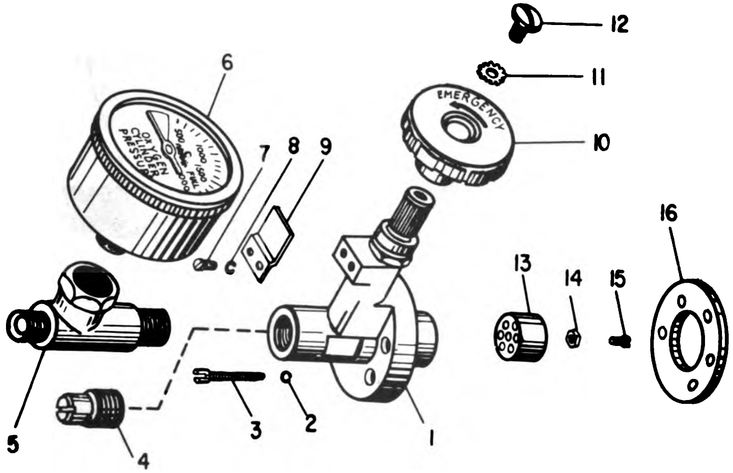


Figure 6-2.—Exploded view of inlet valve and emergency valve assembly.

1. Emergency valve assembly.
2. Lockwasher.
3. Screw.
4. Shipping plug.
5. Tee.
6. H/P oxygen gage.
7. Screw.
8. Lockwasher.
9. Emergency valve stop.
10. Emergency valve knob.
11. Shakeproof lockwasher.
12. Screw.
13. Inlet valve and insert assembly.
14. Nut.
15. Screw.
16. Oxygen inlet gasket.

assembly. Loosen the nut (14) and remove the setscrew (15) from the inlet valve. Use extreme care when handling the inlet valve. The valve must be kept smooth, flat, and free from nicks. The inlet valve and insert assembly and its mating part (oxygen inlet orifice) are not interchangeable with the same two parts of other regulators. If it is necessary to replace the inlet valve and insert assembly, a new orifice should also be installed.

DISASSEMBLY OF THE EMERGENCY VALVE ASSEMBLY.—Disassembly of the emergency valve assembly is necessary when an emergency valve shaft leak is noted or if there is any doubt as to the condition of the packings. A complete breakdown of the emergency valve assembly is shown in figure 6-3.

As shown in figure 6-3, there are four packings (8). Sometimes during overhaul or repair, only three of these packings will be found on the emergency valve shaft.

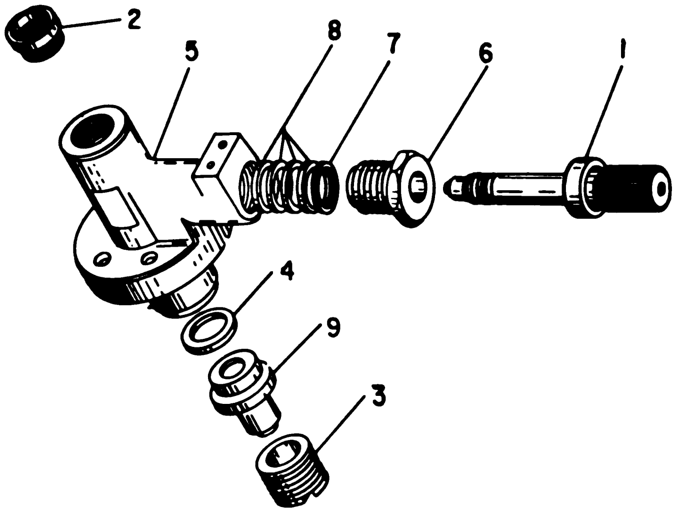


Figure 6-3.—Exploded view of emergency valve assembly.

1. Emergency valve shaft.	6. Stuffing box nut.
2. Retainer and screen assembly.	7. Washer.
3. Orifice nut.	8. Packings.
4. Gasket.	9. Oxygen inlet orifice.
5. Emergency valve body.	

There were only three packings used on the older type regulators, but the factory specifications now call for four on all 2858 series regulators. Therefore, if there are only three packings on the shaft, install four of them when reassemblying.

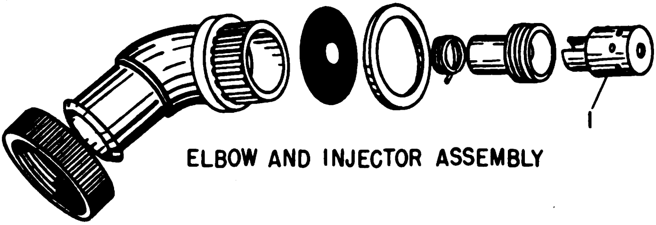
The first step on disassembly of the emergency valve assembly is to remove the retainer and screen assembly (2) from the emergency valve body (5). It will be necessary to distort the retainer and screen in order to remove it. Use a new one upon reassembly. Remove the orifice nut (3) using the orifice nut wrench (special tool QC70736-3) from the other end of the emergency valve body. Lightly tap the emergency valve body to free the oxygen inlet orifice. Remove the gasket (4) from the oxygen inlet orifice. With a pair of small wrenches, loosen the stuffing box nut (6) and unscrew the emergency valve shaft assembly (1) from the emergency valve body. Unscrew the stuffing box nut from the emergency valve body and pull the shaft with the washer

(7) and packings (8) out of the body. Work the packings and washer off the shaft. Do not attempt to remove the ball and spacer from the emergency valve shaft. If either part is damaged, replace the emergency valve shaft assembly.

Injector Assembly

The purpose of the injector assembly is to supply larger amounts of oxygen under greater flows (suction).

REMOVAL AND DISASSEMBLY OF THE INJECTOR ASSEMBLY.—In order to have access to the injector assembly for removal and disassembly, it will be necessary to first remove the elbow outlet assembly by unscrewing the elbow nut and work the elbow off the case. The elbow and case and locating pin have complementary serrations. Be careful not to damage the serrations when separating the elbow assembly from the case. Using a pair of tweezers, remove the gasket and slide the elbow nut off the elbow. Slide a finger through the elbow and push the elbow screen out of the elbow. The baffle plate is soldered to the elbow screen and further disassembly



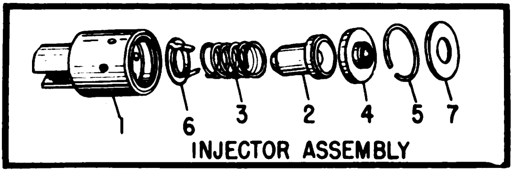


Figure 6-4.—Exploded view of injector assembly. (Pioneer Type 2858-A1, -A1A, -B1, and -C1).

1. Housing.	5. Snap ring.
2. Nozzle.	6. Damping spring.
3. Spring.	7. Gasket.
4. Seat.	

must not be undertaken. Damage or wear to either part necessitates replacing the elbow screen.

To remove and disassemble the injector assembly (fig. 6-4) use a pair of long-nosed pliers, and work the lockspring off the venturi. Unscrew the venturi from the case, using a wide-bladed screwdriver. Using a pair of long-nosed pliers, extract the injector assembly from the case, being careful not to mar the surface of the injector assembly. With a pair of tweezers, remove the gasket (7) that rests on the injector seat (4). With a thin-bladed screwdriver, release the injector snap ring (5) and remove the injector seat. Tip the injector housing (1), and then the injector nozzle (2), damping spring (6), and injector spring (3) will drop out. Extreme care must be used in handling the injector nozzle and injector seat. The surface of each must be smooth, flat, andfree from nicks. Slide the injector spring and the damping spring off the injector nozzle.

Air Valve Assembly

The air valve assembly is the diluter feature of the diluter demand regulator. The air valve assembly consists of an air valve body, an air valve knob assembly, a spring retainer, spring, gasket, screen, and a shakeproof washer. (See fig. 6-5.) The air valve control knob is

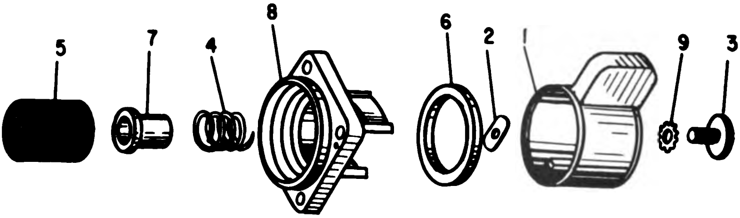


Figure 6-5.—Exploded view of air valve assembly (Pioneer Types 2858-A1, -A1A, -B1, and -C1).

1. Air valve knob.
2. Gasket.
3. Screw.
4. Air valve spring.
5. Air valve screen.
6. Air valve body gasket.
7. Spring retainer.
8. Air valve body.
9. Shakeproof lockwasher.

manually controlled and marked "OFF" or 100 percent oxygen and "ON" or normal oxygen. The body has partial cutouts in each side. When the control knob is turned, two pins in the knob ride in these cutouts to partially separate the knob and body, allowing air to enter. When removing the air valve knob, care must be used to avoid dropping the check valve and aneroid assembly.

REMOVAL OF AIR VALVE KNOB.—Take out the four screws and lockwashers securing the air valve body to the case. Remove the gasket and lift out the check valve and aneroid assembly. Do not remove the locating pin from the case unless it requires replacement.

With a pair of tweezers, lift the air valve screen (5) out of the air valve body. Remove the screw (3) and shakeproof washer (9). Tip the knob and the spring retainer (7) and the air valve spring (4) will drop out. Slide the air valve body (8) out of the air valve knob assembly (1). With a pair of tweezers, remove the gasket from the air valve knob assembly. Further disassembly of the air valve knob assembly must not be undertaken. Damage to either part will require replacement with a new assembly. If necessary for replacement, pry loose the air valve body gasket (6) on the underside of the air valve body.

Check Valve and Aneroid Assembly

The check valve and aneroid assembly consists of a disc, a retainer, a spring, an aneroid assembly with a throttling plate on one end, and an air valve flange on the other. (See fig. 6-6). The throttling plate is separated from the aneroid assembly by a spring washer. The only purpose of the throttling plate is to start metering the air at 20,000 feet to attain the correct air-oxygen mixtures.

The aneroid assembly is comprised of an evacuated bellows containing a spring and an evacuation tube. It is sensitive to atmospheric pressure, and altitude causes expansion. The aneroid expands against the throttling plate seat between 28,000 and 32,000 feet, closing off the atmospheric air. The diluter check valve is spring loaded and opens inward by inhalation and venturi tube suction. It prevents the escape of air-oxygen mixture on exhalation, and the escape of oxygen if the emergency

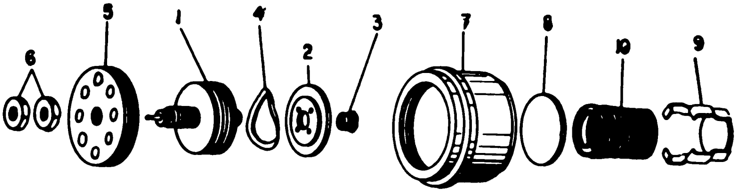


Figure 6-6.—Exploded view of check valve and aneroid assembly (Pioneer Types 2858-A1, -A1A, -B1, and -C1).

1. Aneroid assembly.	6. Nut.
2. Throttling plate.	7. Aneroid housing.
3. Plate retaining nut.	8. Check valve disc.
4. Spring washer.	9. Check valve retainer.
5. Air valve flange.	10. Check valve spring.

valve is used. It prevents excessive air entering the regulator until inhalation has started the oxygen flow.

DISASSEMBLY OF CHECK VALVE AND ANEROID ASSEMBLY.—Slightly spread the prongs of the check valve retainer (9) and separate it from the check valve seat (7). Extreme care must be used in handling the check valve seat. The surface making contact with the throttling plate (2) is critical and must not be marred or scratched. The check valve spring (10) and the check valve disc (8) will come off with the check valve retainer. Carefully separate them from the check valve retainer. Using a fixed spanner wrench, unscrew the air valve flange (5) from the aneroid stem. Do not change the adjustment or disassemble the aneroid, the flange, or throttling plate, unless it is necessary to replace damaged parts, since disassembly will require recalibration of this assembly. If it is necessary to disassemble these parts, remove the plate retaining nut (3) and spring washer (4) from the aneroid assembly. Unscrew the two nuts (6) and the air valve flange (5) from the aneroid assembly.

Cover Assembly, Bottom Plate and Diaphragm Assembly

The dial riveted to the cover constitutes the cover assembly. The diaphragm assembly consists of a piece of rubber coated fabric stretched over a ring held in place by thread and cement. The ring is secured to the case with long screws extending from the bottom plate through the regulator.

REMOVAL OF COVER ASSEMBLY, BOTTOM PLATE, AND DIAPHRAGM ASSEMBLY.—Remove the four screws (2) and lift the cover assembly (1) off the case (fig. 6-7). The dial is riveted to the cover, therefore, these two parts cannot be separated. Remove the twelve screws, six short (13) holding the bottom plate and gasket, and six long (12) holding the diaphragm ring. Lift the bottom plate and bottom plate gasket from the case. Unscrew the diaphragm knob (7) and with small pliers remove the nut (3). Lift off the diaphragm washer (8) and diaphragm assembly (4). Remove the diaphragm ring gasket (5). The diaphragm is cemented and tied with thread to the diaphragm ring. Further disassembly must not be undertaken. Damage to the diaphragm will necessitate replacement of the entire diaphragm assembly. Slide the lower disc off the diaphragm link.

Diaphragm Lever Bracket and Demand Valve Assembly

The diaphragm lever and bracket assembly has a nylon bushing pressed into it. It is used as a guide for the demand valve stem. Through linkage and the diaphragm lever, the demand valve is opened and oxygen is furnished to the user.

REMOVAL AND DISASSEMBLY OF DIAPHRAGM LEVER BRACKET AND DEMAND VALVE ASSEMBLY.—Take out the two screws and remove the bracket and bushing assembly (4) from the case, with the diaphragm lever assembly (1) attached. (See fig. 6-8.) Remove the gasket and lift the demand valve stem (5) out of the case. If necessary for replacement purposes, straighten and remove the pin and separate the diaphragm assembly from the bracket and bushing assembly. The nylon bushing is a tight press fit in the bracket and further disassembly must not be undertaken. Damage to either part will necessitate replacement of the bracket and bushing assembly. Remove the two screws and remove the low-pressure valve cap (13) and gasket from the demand

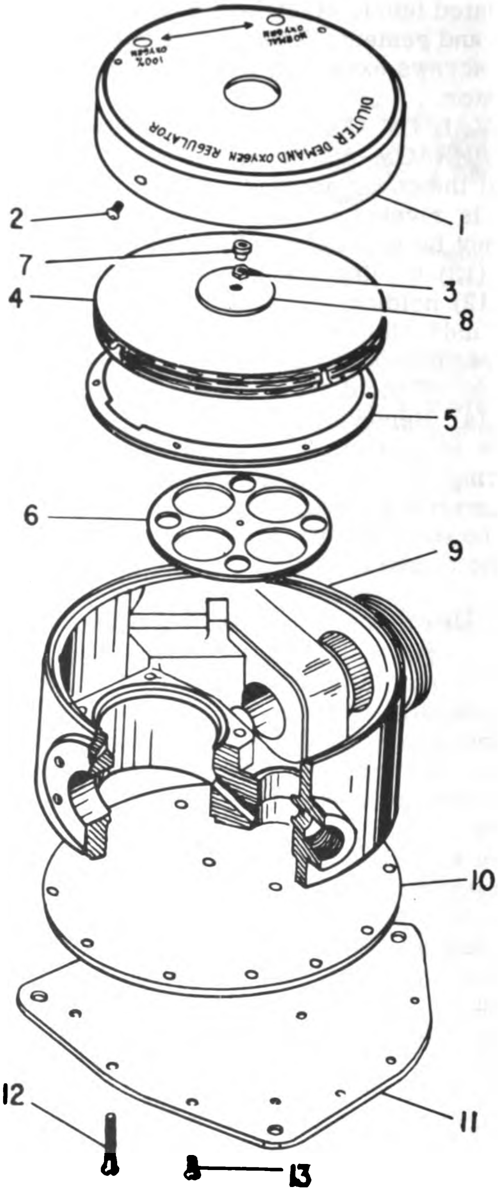


Figure 6-7.—Exploded view of cover assembly, bottom plate, and diaphragm assembly (Pioneer Types 2858-A1, -A1A, -B1, and -C1).

Nomenclature for figure 6-7.

1. Cover assembly.
2. Screw.
3. Nut.
4. Diaphragm assembly.
5. Diaphragm gasket.
6. Lower disc.
7. Diaphragm knob.
8. Diaphragm washer.
9. Case.
10. Bottom plate gasket.
11. Bottom plate.
12. Screw, long.
13. Screw, short.

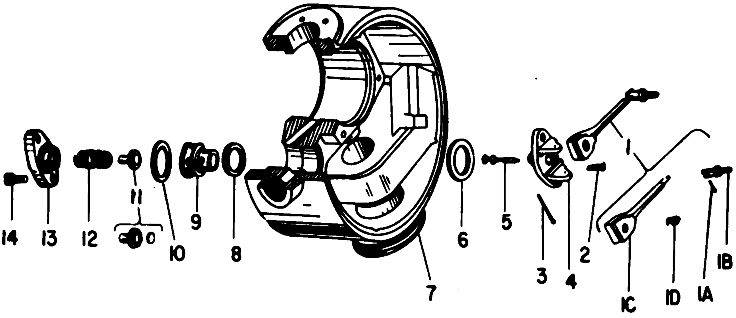


Figure 6-8.—Exploded view of the diaphragm lever bracket and demand valve assembly (Pioneer Types 2858-A1, -A1A, -B1, and -C1).

1. Diaphragm lever assembly.
1A. Pin.
1B. Diaphragm link.
1C. Diaphragm lever.
1D. Setscrew.
2. Screw.
3. Pin.
4. Bracket and bushing assembly.
5. Demand valve stem.
6. Gasket.
7. Case.
8. Gasket.
9. Demand valve.
10. Gasket.
11. Demand valve seat and holder.
12. Demand valve spring.
13. Low-pressure valve cap.
14. Screw.

valve chamber. Remove the demand valve spring (12) and the demand valve seat holder (11) with its demand valve seat. Using extreme care to avoid damage to the valve seat holder, pry the valve seat out of the valve seat holder. Reinsert the valve seat with reverse side up. If the demand valve seat has previously been reversed, replace with a new seat. Lightly push the demand valve (9) out of the case, being careful not to damage the demand valve. Remove the gasket from the case.

Relief Valve and Pressure Reducer Assembly

A relief valve seat holder and valve seat placed in the top cover are held in place by the relief valve spring and guide. These parts comprise the relief valve assembly. The relief valve is to prevent damage to the regulator, particularly to the diaphragm due to excessive pressure. The relief valve will vent at 90 p.s.i. to 165 p.s.i., dumping the excessive pressure around the working parts of the regulator to the elbow outlet. The pressure reducer assembly consists of a pressure reducer lever, link screw, pins, adjusting screw, bellows spring, spacer, and a bellows dampener to prevent vibration. The pressure reducer assembly reduces the inlet pressure to 48 ± 1 p.s.i., and supplies a constant pressure to the demand valve.

REMOVAL OF RELIEF VALVE AND PRESSURE REDUCER ASSEMBLY.--Remove the four screws and lift the relief valve assembly (1) and gasket out of the case. (See fig. 6-9.) Since this assembly requires separate calibration and special test equipment, the guide was cemented into the top cover at the factory. The guide must not be loosened or adjusted except when specified. Damage or wear to any part of the assembly will necessitate replacement of the relief valve assembly. Carefully remove the bellows dampener (4). Some models do not have a bellows dampener. To prevent excessive vibration and oxygen leakage at low temperatures, this part must be used upon reassembly. Take out the four screws and remove the pressure reducer assembly (7) from the bottom of the case. Remove the adjusting screw (11), and with a pair of tweezers remove the spacer.

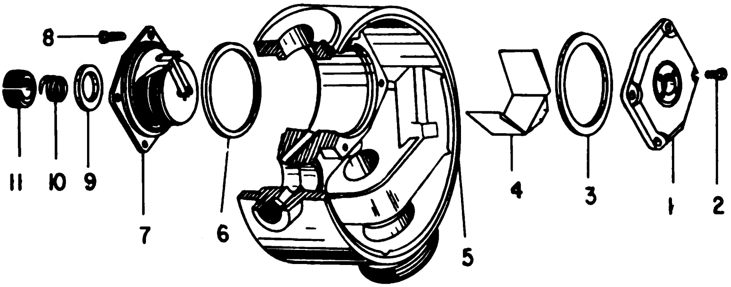


Figure 6-9.—Exploded view of the relief valve and pressure reducer assembly (Pioneer Types 2858-A1, -A1A, -B1, and -C1).

1.	Relief valve assembly.	7.	Pressure reducer assembly.
2.	Screw.	8.	Screw.
3.	Gasket.	9.	Spacer.
4.	Bellows dampener.	10.	Bellows spring.
5.	Case.	11.	Bellows adjusting screw.
6.	Gasket.		

Cleaning, Inspection, Testing, and Reassembly

After disassembly, it is essential to keep all parts absolutely clean and free from dust so that the complete instrument will function properly when reassembled.

REASSEMBLY OF THE EMERGENCY VALVE ASSEMBLY.—Using a magnifying glass, examine the oxygen inlet valve and orifice carefully for signs of wear or damage. The valve seat surface must be smooth, flat, and free from nicks. Polish the orifice face with 0000 polishing paper, wash thoroughly with Freon 113, and dry with clean, oil-free air. If the inlet valve and orifice do not meet these conditions, they must be replaced. Examine the ball and spacer on the end of the emergency valve shaft; if they show signs of wear or damage, replace the shaft.

NOTE: Before beginning reassembly of the emergency valve assembly, be sure the proper emergency valve body is used. The body orifice, which determines the amount of emergency flow of oxygen, differs according to Pioneer Types 2858-A1, -A1A, and the 2858-B1, -C1. The emergency valve bodies are not interchangeable with other regulators of the same type. Other than part numbers, the only positive method of determining the size of the body orifice is on the emergency valve flow test in the test stand.

Insert the gasket into the emergency valve body as far as it will go. (See fig. 6-2.) Place the oxygen inlet orifice, wide end first, next to the gasket. Using the orifice nut wrench, special tool QC70736-3, screw the orifice nut into the emergency valve body to secure the orifice in position. Insert the new retainer and screen assembly into position in the emergency valve body. Apply a small amount of emergency valve shaft lubricant, Dow Corning DC-7, Stock No. 7500-434000, over the washer, the four new packings, and the first two threads of the emergency valve shaft assembly.

Place the stuffing box nut, the washer, and the four packings on the emergency valve shaft, in the order named, and screw the shaft part way into the emergency valve body. Screw the stuffing box nut into the emergency valve body. Tighten the shaft in the body until the ball in the shaft seats itself over the orifice in the body. Tighten the stuffing box nut sufficiently to permit the shaft to be turned with the fingers. Fasten the emergency valve stop to the emergency valve assembly with the two screws and lockwashers.

Slide the emergency valve knob over the knurled surface on the end of the emergency shaft. The knob must be replaced in such a position that, when the emergency valve is completely closed with the ball seated over the orifice in the body, there is one notch between the emergency valve stop and the start of the knurled cutout in the knob. Secure the emergency valve knob to the shaft with the shakeproof washer and screw. Place a drop of spar varnish or glyptal in the threads of the inlet valve and insert assembly, and replace the screw and nut into place.

Using a 1-inch micrometer, adjust the screw so that the distance from the front face of the inlet valve to the screw head is 0.519 inch, as shown in figure 6-10. If there is no micrometer available, a machinist scale may be used, setting the length of the inlet valve at 33/64 inch. Lock the screw into place by tightening the nut. Clean off all excess cement.

Holding the inlet valve by the screw, insert the valve into the body of the emergency valve, so that the center nylon insert is against the oxygen inlet orifice. Position

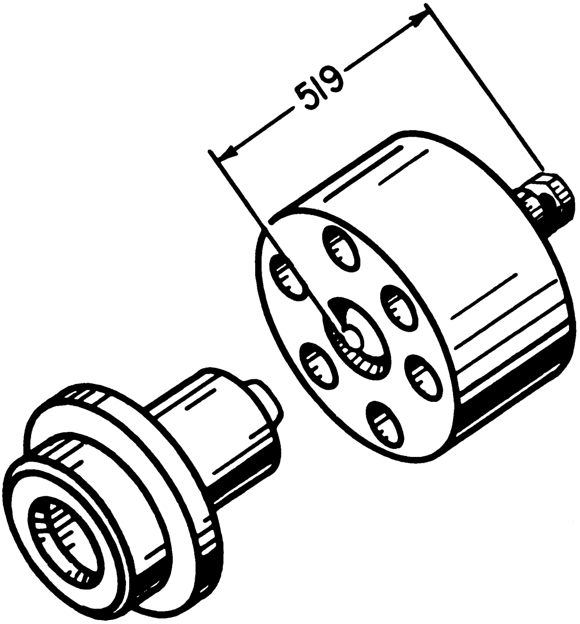


Figure 6-10.—Inlet valve assembly setting.

the gasket on the emergency valve body with the hole for the emergency flow matching the hole in the body. Position the emergency valve body on the case so that the emergency valve shaft is on the topside of the case. (The emergency valve bypass hole is in the topside of the case.) Secure the emergency valve assembly to the case with the four screws provided. NOTE: Use extreme caution when tightening any screw or nut on the case. The case is soft metal, and the threads are easily stripped. A stripped thread or broken screw will probably necessitate the replacement of the case, which means survey of the complete regulator.

REASSEMBLY OF THE DEMAND VALVE ASSEMBLY.—Slip the new gasket over the shoulder of the small end of the demand valve and place it, gasket side down, in the demand valve chamber. Make certain it becomes seated as deeply as possible. The demand valve has four holes spaced around the side of the larger end. Seat the valve in the demand valve chamber so that one of these holes is opposite the diagonal hole in the case. Use a new demand valve seat, or reverse the old one and set it into the demand valve seat holder. Place a new gasket over the low-pressure valve cap. NOTE: There are three gaskets used in the complete demand valve and bracket bushing assembly—two thin ones and one thick one. The thick one is used on the low-pressure valve cap. Insert the demand valve spring and the demand valve seat holder into the low-pressure valve cap, making sure they move freely and do not stick. NOTE: The demand valve and injector springs are very similar in appearance. THEY ARE NOT INTERCHANGEABLE. The injector spring can be identified by the tension, which is slightly stronger than the demand valve spring. As shown in figure 6-11, the injector spring is tapered flat on the end.

Raise the regulator case with the bottom side facing down, insert the low-pressure valve cap in the case, with the spring, seat holder, and seat in a vertical position. Secure the low-pressure valve cap to the case with two screws. Take care to tighten the screws evenly so as not to cock the valve seat holder and thereby injure the valve seat. When secured in position, push the valve open several times with a blunt rod to make sure it does not stick and that the valve seat is properly seated in place.

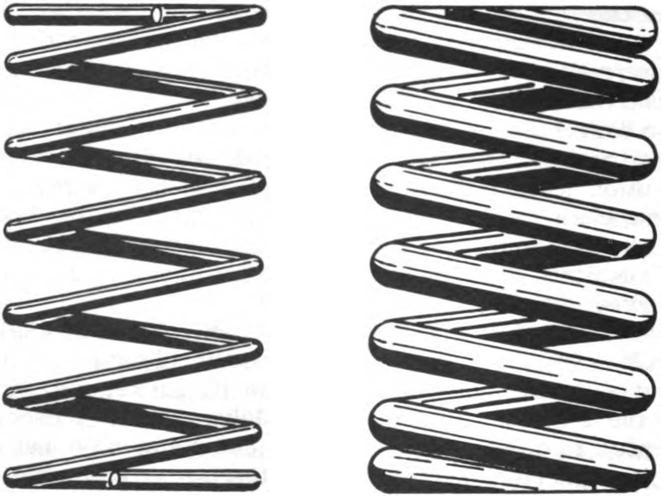


Figure 6-11.—Demand valve and injector springs.

REASSEMBLY AND SETTING OF THE PRESSURE REDUCER ASSEMBLY.—Screw the pressure reducer link screw in the pressure reducer bellows cap so that the pinhole is 9/64 inch above the surface of the bellows cap. After adjusting the height of the link screw, slide the pin through the lever and the top of the link screw. Bend the pin over, making sure that the pin will not interfere with the deflection of the bellows. Position the gasket on the rim of the pressure reducer assembly. Place both in position in the bottom of the pressure reducer chamber so that the short leg of the pressure reducer lever is next to the inlet valve and insert assembly. Secure the pressure reducer to the case with the four screws, being careful to tighten all screws evenly. Shut off the emergency valve.

Connect the high-pressure fitting in the emergency valve body to a gas supply with a pressure reducer regulator. Adjust the pressure reducer regulator to 100 p.s.i. inlet pressure. There will be a flow out of the top of the pressure reducer chamber. Press down the pressure reducer lever with a wide-bladed screwdriver. The gas must shut off when the lever is horizontal or just below horizontal. This position is important in obtaining the correct volume for the pressure reducer chamber. If the lever shuts off above horizontal, the adjusting screw must be turned clockwise into the inlet valve. If the lever shuts off at more than slightly below horizontal, the adjusting screw must be turned counterclockwise out of the inlet valve. This is a trial and error process. Change the adjustment a little at a time. Lock the adjusting screw in place by tightening the nut.

If the lever is adjusted too high, the volume in the pressure reducer chamber will be inefficient for proper suction. If the lever is adjusted too low, the adjusting screw will project too much when the pressure reducer assembly is adjusted. Place the bellows dampener around the pressure reducer bellows. Attach a 0-60 pound gage to the pressure reducer chamber, making certain to place the gasket between the gage and the case.

A suitable gage for this purpose is the Pioneer Gage No. 13302-1.

Place the spacer (beveled side first), copper-plated bellows spring, and adjusting screw into the pressure reducer assembly. Connect regulator to a controllable source of supply, and adjust the oxygen inlet pressure to 100 p.s.i. Adjust the adjusting screw so that the pressure gage reads 48 ± 1 p.s.i. For more pressure adjust the screw clockwise and for less pressure, counterclockwise. After the pressure reducer has been set to 48 ± 1 p.s.i., open the demand valve seat with a small rod. Allow the demand valve to close by lifting the rod from the seat. Note the pressure of the gage when the oxygen ceases to flow. The reading of the pressure gage must not increase more than 3 pounds. If the creep is more than this, reset the adjusting screw in the pressure reducer assembly by turning it clockwise approximately 1/8 inch.

This adjustment puts considerable pressure on the bellows and tends to form a seat on the inlet valve and insert assembly. If this adjustment is necessary to prevent creep, tighten the adjusting screw until the pressure gage again reads 48 ± 1 p.s.i. If the pressure creeps more than 3 pounds, but gradually shuts off before reaching the capacity of the gage, a defective oxygen inlet orifice, inlet valve and insert, or improper adjustment of the pressure reducer lever is indicated. If the reading of the pressure gage creeps continually until it indicates the same as the reading set at the oxygen supply, a leak at the gasket between the oxygen inlet orifice and emergency valve body is indicated. To remedy this situation, tighten the orifice nut, pressing the orifice against the gasket. A defective thread in the body may cause the nut to appear to be in tight before it actually seals the gasket. Check the pressure reducer assembly for vibration by opening and closing the demand valve several times. The bellows dampener must be used to eliminate vibration.

REASSEMBLY OF THE DIAPHRAGM LEVER AND BRACKET ASSEMBLY.—Polish the small diameter end of the demand valve stem with 0000 polishing paper. Wash thoroughly with Freon 113 and dry with clean, oil-free dry air. Check the operation of the demand valve stem in the bracket and bushing assembly to make sure that it operates freely and does not stick. If it sticks in the bushing, replace it with a new stem. Inspect the bushing of the bracket assembly for wear. The hole must be smooth and without burrs.

Examine the diaphragm lever setscrew. The bottom of the setscrew must be smooth and flat. Push the tapered end of the diaphragm lever in the fork of the diaphragm link, and slip the pin through both the link and lever. (See fig. 6-8.) Fit the other end of the diaphragm lever in the bracket and bushing assembly in such a manner that the hole for the setscrew is directly over the bushing pressed into the bracket. Slip the pin through both the bracket and the lever. Bend the end of the pins to secure the link and lever into position.

Assemble the setscrew in the diaphragm lever. The side play between the diaphragm lever and the diaphragm lever bracket is to prevent sticking, in the event of frost. Use an Allen wrench when tightening the setscrew. Place the new gasket on the shoulder of the casting over the demand valve. Place the demand valve stem in the demand valve with the flanged end on top of the valve seat. Slide the protruding end of the valve stem into the bushing in the bracket, and secure the bracket and bushing assembly to the case with the two screws. Loosen the setscrew, and with 100 p.s.i. inlet pressure applied to the regulator, adjust the height of the diaphragm lever by means of a setscrew. It is adjusted as shown in figure 6-12, so that the highest point of the diaphragm lever, with the link hanging down vertically, is exactly 11/64 inch above the top edge of the regulator case.

This distance is important and may be determined with a scale and straightedge, as shown in figure 6-12 (A), or by using a lever setting gage (fig. 6-12 (B)). The lever setting gage is made from aluminum or steel and may be manufactured locally.

In using the lever setting gage, lay it across the regulator and adjust the setscrew so that the diaphragm lever just touches the top of the 11/64-inch slot. (The 33/64-inch pin shown on the gage may be used for setting the diaphragm lever on automatic positive pressure diluter demand regulators, discussed in chapter 7.)

After the diaphragm lever is properly adjusted, it should be checked for freedom of movement. Sluggishness is a sign of friction which must be corrected before proceeding further.

REASSEMBLY OF THE INJECTOR ASSEMBLY.—Slide the injector spring over the injector nozzle, as shown in the

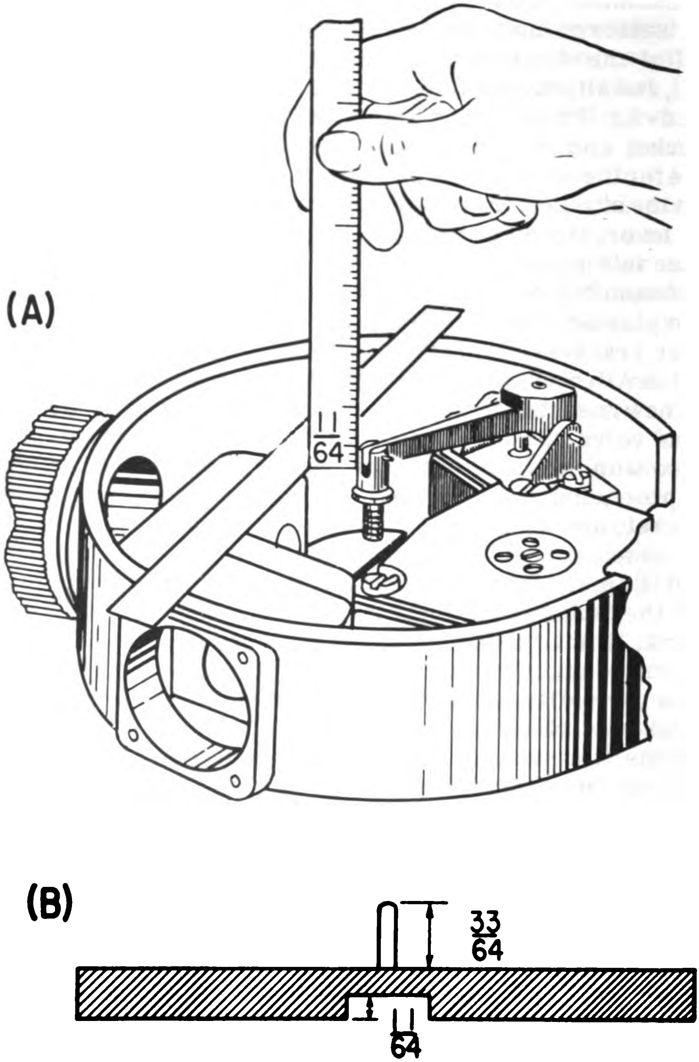


Figure 6-12.—Adjusting the height of the diaphragm lever.

exploded view in figure 6-4. As mentioned before, it is very easy to get the demand valve spring and the injector spring mixed up. It is of utmost importance that the proper spring be used in order for the regulator to function properly. Place the damping spring over the sloped end of the injector nozzle. Place the injector nozzle, with the spring and damping spring, into the injector housing.

Place the injector seat over the injector nozzle, with the beveled surface of the seat next to the injector nozzle. Use extreme care in handling the injector seat. The valve seat surface must be smooth, flat, and free from nicks to provide a perfect fit with the injector nozzle. Hold down the injector seat, compressing the spring, and insert the injector snap ring in the groove in the injector housing. Slide the gasket end of the injector assembly into the case through the elbow opening directly opposite the pressure chamber.

Screw the venturi over the injector assembly into the case, thereby securing the injector assembly in place. Press the lock spring over the slotted end of the venturi until the last coil, with the bent end, is even with the venturi. Lock the spring to the case by bending the end of the spring with a pair of pliers until it grips against the casting of the case.

CHECKING THE INJECTOR ASSEMBLY.—The injector assembly is checked to determine at what pressure the injector nozzle unseats itself, allowing the added flow of oxygen to the user. Attach a 0-60 pound gage into the flow indicator outlet leading to the demand valve chamber.

Connect the regulator to a controllable source of oxygen and set 150 p.s.i. inlet pressure. Gradually depress the diaphragm lever until oxygen starts to flow through the radial holes of the injector housing. During this operation, the gage on the flow indicator outlet will slowly rise and then hesitate a few seconds before continuing to rise. This hesitation of the gage indicates the injector nozzle is lifting off the injector seat. When this condition exists, the oxygen pressure gage on the demand valve outlet must read not less than 13 p.s.i. nor more than 25 p.s.i.

If the gage reading is less than 13 pounds, the injector spring is too weak and should be replaced with a stronger one. If the gage reading is more than 25 pounds, the injector spring is too strong and should be replaced with a weaker one. Repeat the test after replacing any springs. With the diaphragm lever fully depressed, check the injector assembly for vibration. If it "howls," the damping spring must be replaced.

There is an alternate method that can be used to check the unseating of the injector nozzle. Place a drop of soap solution in the radial holes of the injector housing. When the injector nozzle unseats, bubbles will appear around the housing. Read the pressure gage simultaneously.

Remove the pressure gages. Apply a small amount of antiseize compound to the threads of the plug, and screw the plug into the outlet leading to the demand valve. Place the gasket over the opening of the pressure reducer chamber, and secure the relief valve assembly to the case with the four screws.

REASSEMBLY OF COVER ASSEMBLY, BOTTOM PLATE, AND DIAPHRAGM ASSEMBLY.—Carefully turn the case over with the relief valve assembly facing down, being careful not to damage the diaphragm lever. Place the new bottom plate gasket and bottom plate over the case. Line up the twelve screw holes in the gasket and plate with the screw holes in the case. Secure the bottom plate and gasket to the case, using the six short screws.

Turn the case over so that it is resting on the bottom plate. Place the diaphragm ring gasket on the shoulder of the case. Turn up the diaphragm link and slide the lower disc over it. Insert the diaphragm link through the center hole in the diaphragm assembly. Slide the diaphragm washer over the link protruding through the diaphragm. Screw the nut over two or three threads on the diaphragm link to prevent the link from dropping out of the diaphragm. Do not tighten the nut at this time. The diaphragm will have to be rotated to line up the screw holes. This will wrinkle the diaphragm if the nut is tight.

Holding the diaphragm assembly in position, turn the case over and secure the diaphragm assembly to the case, using the six long screws. Screw the nut securely on the diaphragm link protruding through the diaphragm. Place the cover assembly over the diaphragm and line up the four screw holes in the case with those in the cover. The screw holes in the cover are spaced in such a manner that when the holes in the case and cover are lined up, the dial riveted to the cover is in correct position in relation to the emergency valve and air inlet. Secure the cover to the case with the four screws.

REASSEMBLY OF ELBOW ASSEMBLY.—Slightly bend the elbow screen cup-shaped, and insert it into the wide end of the elbow so that the baffle plate will be nearest the venturi when assembled. Flatten the elbow screen to hold the baffle assembly in place in the elbow. Slide the elbow through the elbow nut and place the new gasket in the nut against the elbow, thereby holding them together. Line up the serrations on the elbow and case and push the elbow into the case. Screw the elbow nut to the case over the injector assembly. When lining up the serrations on the elbow, place it in a downward position. This will eliminate any possibility of soap solution entering the regulator while testing for leaks. The elbow can later be placed in any direction to suit the conditions for mounting in the aircraft.

REASSEMBLY OF CHECK VALVE AND ANEROID ASSEMBLY.—One function of the check valve is to prevent escape of oxygen when pressure, either from exhaling or opening of the emergency valve, exists in the regulator. Another function is to prevent any flow of air until a definite suction is built up in the case. Without the check valve and at flows required by normal breathing, sufficient air could be drawn through the instrument without causing any flow of oxygen at altitudes below 20,000 feet. The check valve spring must be adjusted so that the oxygen-air mixture will not be too lean at small flows. If the check valve spring is too stiff, the oxygen content of the mixture will be too high at small flows. With the correct spring tension, the mixture will be uniform for flows between 15 and 50 l.p.m., which is the normal range of flows. Because of the differences in the suction flow characteristics of each regulator, the check valve spring must be adjusted to the particular instrument.

Examine the check valve seat for wear. The surface making contact with the throttling plate must be smooth and flat. Polish with 0000 polishing paper, wash thoroughly with Freon 113, and dry with clean, oil-free air. Inspect both surfaces of the throttling plate. They must be smooth, flat, and free from nicks. If the part does not meet these conditions, replace it. If a new throttling plate is to be used, it must slide freely on the plate retaining nut.

Place the spring washer on the bottom of the aneroid assembly. (See fig. 6-6.) The spring washer must be crimped or bent 5/32 inch from a flat surface before assembly. Slide the throttling plate on top of the spring washer. The spring washer fits around the hub of the throttling plate. Place the extended portion of the plate retaining nut through the hole in the throttling plate and screw the plate retaining nut on the bottom portion of the aneroid assembly. Tighten the nut as far as it will go.

The throttling plate must rock and rotate freely and must not stick or cock; otherwise it will not shut off the flow of air at high altitudes. Slightly ream the hole in the throttling plate if it binds on the extended portion of the plate retaining nut. The spring washer must be just stiff enough to insure proper positioning of the throttling plate and to prevent vibration which will cause excessive wear. Too stiff a spring washer will be detrimental to the action of the aneroid. The spring washer may be adjusted by bending.

Screw the air valve flange on the top portion of the aneroid assembly. The exact position of the aneroid to the flange and throttling plate seat will be determined during the check for aneroid closure on the test stand. For a preliminary adjustment, screw the flange on the aneroid assembly until the flange is approximately 1/8 inch from the aneroid bottom. After adjusting the flange, lock it in place with the two nuts. Place the aneroid assembly, plate retaining nut first, into the check valve seat. Screw the air valve flange into the check valve seat as far as it will go using a fixed spanner wrench.

Place the check valve spring inside of the check valve retainer, and place the check valve disc on top of the check valve spring. Snap the check valve retainer on the check valve seat. Make sure the disc moves freely when the spring is compressed. Also, make certain that the retainer is firmly clamped in place to the check valve seat so that it will not move under vibration. The check valve disc must completely cover the opening in the check valve seat, in any position, when it is flush against the check valve seat. The valve seat surface must be smooth and flat to insure proper throttling at high altitudes. Place the gasket on the shoulder of the check valve seat.

Insert the check valve and aneroid assembly, check valve retainer first, into the case as far as it will go. Line up the locating pin in the case with the hole in the air valve body and press the body and cover assembly in position over the check valve and aneroid assembly. The locating pin is used to position correctly the lever button in relation to the dial. Secure the body and cover assembly to the case with four screws and lockwashers.

Performance Check Sheet Preparation

In order to test a regulator for the various tests required, particularly the oxygen ratio test, a performance worksheet must be prepared. There is a standard procedure that must be followed in order to properly prepare a performance worksheet. There is a simple, easy to use worksheet shown in table 6-1.

OXYGEN RATIO.—The oxygen ratio test, which is the bottom part of the worksheet shown in table 6-1, is the most difficult part of the worksheet to prepare. The procedure for preparing the oxygen ratio portion of the worksheet will be given first.

The purpose of the oxygen ratio test is to determine at various altitudes the proportions of oxygen and air in l.p.m. flows passing through the regulator. The test is accomplished by setting selected output flows and measuring the input flows to the chamber at specified test altitudes. A performance check worksheet must be prepared and used for each different type regulator to be tested.

MATERIALS REQUIRED FOR WORKSHEET PREPARATION FOR THE 2858-A1, -A1A, -B1, and -C1:

1. Manual (AN 03-50A-5) for the regulator which specifies the test altitudes and oxygen percentages to be used. These altitudes and percentages are found in section VII, paragraph 4, table VIII.
2. Output flowmeter calibration curve graph for the test stand being used.
3. Input flowmeter calibration curve graph for the test stand being used.
4. Air-oxygen conversion graph showing the added oxygen percentages.

Table 6-1.—Performance check worksheet for 2858-A1, -A1A, -B1, and -C1.

Regulator Performance Check Sheet
2858-A1, -B1, and -C1

Date ____________ Regulator type ____________________ Test stand No. ____________________
Operator ____________________________ Regulator serial No. ____________________

1. High-pressure leak ________________
2. Outward leak test: Normal ______________________ 100 percent ______________________
3. Inward leak test _________________
4. Flow suction test (100 percent)
5. Emergency flow test: A1-A1A, B1, and C1 100 p.s.i. 30 to 40 l.p.m. ____________________
6. Aneroid air valve closure ____________________ altitude
7. Oxygen ratio test (normal)

Altitude (feet)	Inlet pressure	Actual output	Indicated output	Corrected indicated output	Maximum suction	Suction
Sea Level	50	30			0.40	
Sea Level	50	40			0.97	
Sea Level	150	70			1.50	
15,000	50	30			0.40	
15,000	50	50			0.97	
15,000	150	85			1.50	

Table 6-1.—Performance check worksheet for 2858-A1, -A1A, -B1, and -C1—Continued.

Altitude (feet)	Oxygen percent	Percent average	Actual output	Indicated output	Corrected indicated output	Actual		Indicated		Reading
						HI	LO	HI	LO	
5,000										
5,000										
5,000										
10,000										
10,000										
10,000										
15,000										
15,000										
15,000										
20,000										
20,000										
20,000										
25,000										
25,000										
25,000										
28,000										
28,000										
28,000										
32,000										
32,000										
32,000										

The first step in preparing the oxygen ratio test is to determine the actual flows to be used and convert them to indicated flows, then to corrected indicated flows.

Table 6-2 specifies the various altitudes to be used. For each altitude, there must be three output flows used. Flows are divided into high and low; 20 to 50 l.p.m. are low flows and 51 to 85 l.p.m. are high flows. Do not confuse these high and low flows with the high and low ranges used during calibrating. There is no connection. The three flows required for each altitude must be either two low and one high, or one low and two high. The flows are selected by the individual and the combination must alternate from 5,000 feet to 32,000 feet. For example, on the output column of the worksheet, list 20, 40, 60, 80, 60, 40, 20 and so on, up and down, in increments of twenty until the column is filled. This will give the required high and low flow combinations for each altitude.

Also shown on table 6-2 are the percentages of oxygen that the regulator must deliver at various altitudes. These figures are to be listed in the second column of the worksheet, according to the actual (total) output high or low value. If the output flow is 20-50 l.p.m., take the percentages from the left column of the table. If the output flow is 51-85 l.p.m., use the right column of the table. The next column to the right on the worksheet is for the average oxygen percentage. This is achieved by adding the two percentages and dividing by two. As an example, for the first flow of 20 l.p.m., which is a low flow, the oxygen percentages are 0.01 and 0.30. Adding these together would give 0.31. Dividing by two would give 15.5, the first figure in the average column. These average oxygen percentages are used later to convert indicated output flows to corrected indicated output flows.

To convert output flows to indicated output flows, the output curve graph will be used. The bottom margin of the output curve graph shows actual flows in l.p.m. Each curve line represents the calibrated flow of air at an altitude. The left side margin of the curve graph shows figures for the indicated flowmeter readings.

The graph for the OTS-565 also has curves for 100 percent oxygen at various altitudes. The graphs for the OT-122C and C11250 are scaled in l.p.m., whereas the

Table 6-2.—Required oxygen percentages at various altitudes.

Regulators, Pioneer Types
2858-A1, 2858-A1A, 2858-B1, 2858-C1

Oxygen Ratio
(Air Valve Normal)

Altitude (feet)	Ratio of cylinder oxygen supplied to total gas delivered	
	Total gas flow 20 to 50 l.p.m.	Total gas flow 51 to 85 l.p.m.
5,000	0.01 to 0.30 inclusive	0.01 to 0.40 inclusive
10,000	0.06 to 0.30 inclusive	0.06 to 0.40 inclusive
15,000	0.14 to 0.32 inclusive	0.14 to 0.45 inclusive
20,000	0.24 to 0.42 inclusive	0.24 to 0.65 inclusive
25,000	0.40 to 0.80 inclusive	0.40 to 0.90 inclusive
28,000	0.70 to 1.00 inclusive	0.70 to 1.00 inclusive
32,000	0.98 to 1.00 inclusive	0.98 to 1.00 inclusive

OTS-565 is scaled in inches of water pressure. Converting liters to inches for use on the OTS-565 will be covered later.

1. Locate the actual output flow along the bottom margin of the graph.
2. Follow the graph line up to the curve line for whatever test altitude desired.
3. From the curve line, follow the graph line to the left margin and read the indicated flow.
4. This indicated flow is to be listed in the indicated output column on the worksheet.
5. Complete this conversion for all the flows at all the altitudes.

To convert indicated flows to corrected indicated flows, the air-oxygen correction graph is used. The bottom margin of the correction graph gives indicated output flown in l.p.m. The curve lines represent the percentage of added oxygen in a flow. The left margin shows the corrected indicated output flow in l.p.m. The percentage curve line used is determined by the oxygen average column on the worksheet. At times there will be an oxygen average that will not hit on a percentage line, so you will have to interpolate.

1. Locate the indicated output flow on the bottom margin of the correction graph.
2. Follow the graph line up to the oxygen percentage curve line desired.
3. Follow the graph line to the left margin and read the corrected indicated output flow. This flow is to be copied down on the corrected indicated flow column on the worksheet.

This completes the conversion of the output flows. These corrected indicated output flows are the flows that will be set on the output flowmeter of the test stand in performing the oxygen ratio test.

As mentioned before, the test stand will measure the ratio of air the regulator is delivering. Shown in table 6-2 are the minimum and maximum percentages of oxygen the regulator must deliver at various altitudes. In order to determine if the regulator is delivering the correct ratio of oxygen and air, the high and low allowable percentages of air must be computed.

To find high air, the low oxygen percentage is subtracted from 100 percent air and the remainder is multiplied by the actual flow for each altitude level.

To find low air, the high oxygen percentage is subtracted from 100 percent air and the remainder is multiplied by the actual flow for each altitude level.

EXAMPLE: Find high and low air for 20 l.p.m. actual flow at 5,000 feet.

SOLUTION: The ratio of cylinder oxygen supplied to the total gas delivered at 5,000 feet is 0.01 to 0.30 percent.

1.00 Air	1.00 Air
-0.01 Oxygen Percent	-0.30 Oxygen Percent
0.99 Air	0.70 Air
x 20 Actual Flow	x 20 Actual Flow
19.80 High Air	14.20 Low Air

The high air and low air are entered in the correct actual high or actual low column provided on the worksheet. These actual high and low allowable air percentages will have to be converted to indicated high and low air. This is accomplished by using the input curve graph. The input graph is read the same way as the output graph, except the input readings are air. After the actual high and low air has been converted to indicated high and low air, these figures are copied in the appropriate indicated high and low columns on the worksheet. INPUT AIR READINGS DO NOT HAVE TO BE CORRECTED.

To complete the worksheet, the flow suction and emergency flow test will have to have the output flows converted to indicated flows. On the flow suction test the altitudes, inlet pressures, actual output flows and the maximum allowable suction are given. The converting of the output flows will be done the same way as the actual output flows were on the oxygen ratio. Using the output curve graph convert the actual output flows to indicated flows and on the air-oxygen correction curve graph convert the indicated output flows to corrected indicated output flows and enter in the appropriate columns.

On the emergency flow test the required output flows, 10-15 l.p.m. and 30-40 l.p.m., will have to be converted the same as was done on the flow suction test.

The OTS-565 (NIL) test stand is calibrated at the factory and output and input curve graphs are furnished with each stand.

OUTPUT CURVE GRAPH.—The output graph has two sets of curves. One set represents air and the other set 100 percent oxygen. For tests such as the flow suction test, where the test is performed on 100 percent oxygen, the 100 percent curve lines are used. When the 100 percent oxygen curve lines are used, the converted inches of water pressure will not have to be corrected. The bottom margin of both the output and input curve graphs are in l.p.m., and the left side margin is in inches of water pressure. The curve lines represent various altitudes.

Locate the l.p.m. flow on the bottom margin of the graph and project upward to the desired altitude curve line. Read to the left margin for the correct inches of water pressure. When using the air-oxygen curve lines, for changing oxygen ratio output flows, the indicated inches of water pressure will have to be corrected for added oxygen. This correction is made using the air-oxygen correction graph and in the same manner as the l.p.m. corrections.

INPUT CURVE GRAPH.—The input curve graph has just one set of lines and is used to convert the l.p.m. input air flows to inches of water pressure flows. It is marked off and used the same as the output graph. Indicated input air flows, either l.p.m. or inches of water pressure, DO NOT have to be corrected.

Test Procedure

LEAK TEST.—A regulator that has been completely overhauled and reassembled cannot perform its mission properly if it leaks in any manner. There are certain prescribed tests to determine if a regulator leaks. These various tests are given in this section along with the possible causes of leakage and their remedies.

The HIGH-PRESSURE LEAK TEST is to determine if there are any leaks in the deamnd valve or internal parts of the regulator. Figure 6-13 illustrates points at which high-pressure leaks are likely to occur.

PROCEDURE FOR HIGH-PRESSURE LEAK TESTING THE 2858 REGULATOR:

1. Close the emergency valve.
2. Connect regulator to controllable source of oxygen.
3. Set 50 p.s.i. inlet pressure.
4. Test the shutoff operation of the regulator by depressing and releasing the diaphragm knob several times.
5. Place a film of soap solution over the opening of the elbow outlet assembly. Soap solution procured from the Medical Department is excellent for this purpose.
6. If there is no expansion of the soap film, repeat test with 500 p.s.i. inlet pressure.
7. If the soap film expands on either inlet pressure more than 3/16 inch, a leak is present.
8. This test should be repeated three or four times to be sure the bubble is not due to the expansion of the gas by heating.

It is rather difficult to measure a 3/16-inch bubble. If there is any expansion, especially if it continues to expand, it can be considered excessive leakage. If there is excessive expansion of the soap film over the elbow, the job of repairing the leak will be greatly simplified if it is determined whether the leak is coming through or around the working parts of a regulator. To determine this, unscrew the elbow nut and remove the elbow assembly. Place a film of soap solution over the end of the venturi. If there is an expansion of the soap film, the leak is through

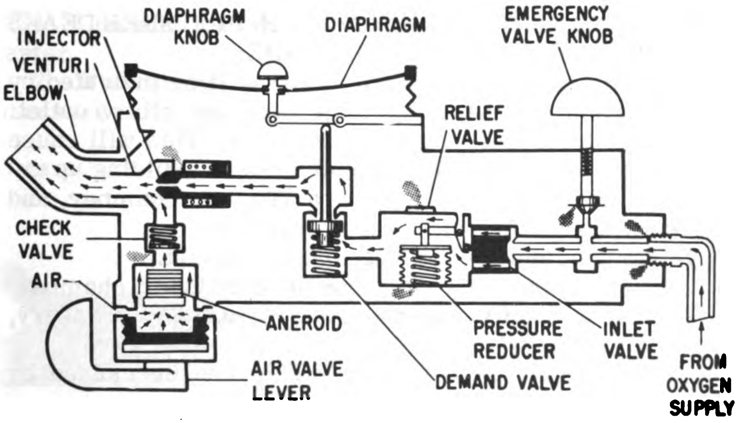


Figure 6-13.—Schematic of 2858 regulators—showing various high-pressure leaks through and around the working parts.

the working parts. If there is no expansion of the soap film, the leak is around the working parts of the regulator.

CAUSES AND REMEDIES OF HIGH-PRESSURE LEAKS THROUGH THE WORKING PARTS ARE:

Leakage through the demand valve would be indicated by an expansion of the soap film over the venturi.

Cause: Demand lever set too high. If the demand valve lever is set too high, the tension of the diaphragm applied to the demand valve lever would open slightly the demand valve seat. This would appear as a continuous flow, but is considered as a high-pressure leak.

Remedy: Reset the demand valve lever to 11/64 inch above the top edge of the regulator case.

Cause: Demand valve seat not seating. This could be caused by the seat being cut or the seat retainer cocked.

Remedy: Replace the demand valve seat.

Cause: Bent or burred demand valve stem.

Remedy: Replace the demand valve stem. Do not attempt to straighten a demand valve stem.

Cause: Wrinkled or tight diaphragm. A wrinkled diaphragm can be caused by the demand valve lever locknut being tightened before the diaphragm assembly was positioned to the case. A tight or stiff diaphragm may be caused by prolonged storage.

Remedy: Reposition or replace the diaphragm assembly.

CAUSES AND REMEDIES OF HIGH-PRESSURE LEAKS AROUND THE WORKING PARTS ARE:

Leakage around the working parts will be indicated by an expansion of the soap film over the elbow outlet.

Cause: Inlet orifice gasket defective. This will cause oxygen to pass around the inlet orifice, building up excessive pressure in the pressure reducer chamber, and venting through the relief valve assembly.

Remedy: Replace the inlet orifice gasket.

Cause: Leakage around pressure reducer chamber.

Remedy: Tighten all the screws; and if necessary, replace the gaskets.

Cause: Inlet valve leaking. This can be caused by the inlet seat being marred or improper setting of the inlet valve assembly. This will cause the same effect as having a defective inlet orifice gasket.

Remedy: Readjust the inlet valve setting or replace the entire inlet valve assembly.

Cause: Leakage around the demand valve chamber.

Remedy: Tighten the screws; or if necessary, replace the gaskets.

Cause: Leakage through the emergency valve channel.

Remedy: Replace the packings and tighten the emergency valve shaft.

Cause: Leakage through the pressure reducer adjusting screw. This can only happen if there is a hole in the pressure reducer bellows.

Remedy: Replace the entire pressure reducer assembly.

The OUTWARD LEAK TEST is to determine if there is any outward leakage of oxygen through the regulator case.

Testing for outward leaks on all regulators can best be accomplished by using an outward-leak tester which can be locally manufactured. Figure 6-14 illustrates a locally manufactured outward-leak tester.

Oxygen pressure is applied to the outlet of the regulator by turning the manual pressure breathing top of the regulator clockwise. The amount of the pressure is indicated on the pressure-suction gage. Any outward leakage will act as a flow, and register on the oxygen manometer.

PROCEDURE FOR TESTING OUTWARD LEAKS ON 2858 REGULATORS:

1. Connect outlet of regulator to the outward leak tester.
2. With air valve on NORMAL, apply 1-inch water pressure to the outlet of the regulator.

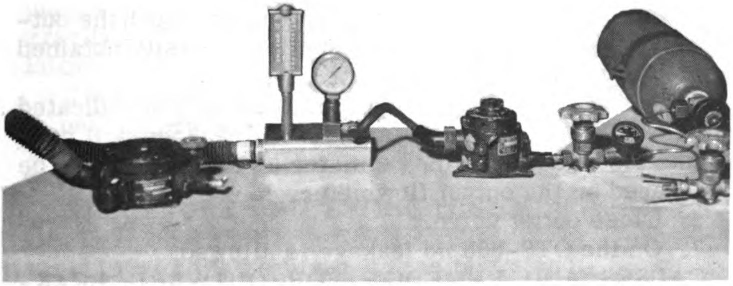


Figure 6-14.—Outward-leak tester, manufactured locally.

3. Allowable leakage (shown on oxygen manometer is 0.8 1.p.m.

4. With air valve on 100 percent, apply 10-inch water pressure to the outlet of the regulator.

5. Allowable leakage is 0.3 1.p.m.

Less leakage is allowed on 100 percent because, with the air valve closed, the possibility of the air check valve leaking is eliminated.

CAUSES AND REMEDIES FOR OUTWARD LEAKAGE ARE:

Cause: Leakage through air check valve on normal. This is caused by a bent or scratched air valve disc.

Remedy: Replace the air check valve disc. Do not attempt to straighten the disc.

Cause: Leakage through air check valve on 100 percent. This leakage is around the air valve body gasket and through the regulator case opening.

Remedy: Tighten the air valve screws; if necessary, replace the air valve gasket.

Cause: Ruptured diaphragm.

Remedy: Replace diaphragm assembly.

Cause: Leakage through any part of the case.

Remedy: Tighten all screws and replace gaskets as necessary.

The INWARD LEAK TEST is to determine if there is any ambient air leaking into the regulator case. The inward leak test is performed in the test stand at sea level.

1. Mount the regulator in the test stand with the diaphragm on a vertical plane.

2. Air valve knob on 100 percent position.

3. Oxygen supply turned off.

4. Open the outlet valve until 1-inch suction is indicated on the pressure-suction manometer. Open the outlet valve with caution as 1-inch suction is easily obtained inside the regulator.

5. Allowable leakage is 0.5 1.p.m. and will be indicated on the output flowmeter. Any inward leakage will pass out the elbow outlet of the regulator as a flow and will be registered on the output flowmeter.

6. Close outlet valve.

7. On the OTS-565 no leakage is allowed.

CAUSES AND REMEDIES FOR OUTWARD LEAKAGES ARE:

Cause: Ruptured diaphragm.

Remedy: Replace the diaghragm assembly.

Cause: Leakage through the case.

Remedy: Tighten all screws and replace gaskets as necessary.

There is one cause for a leak that will appear on an inward leak test that may not on an outward leak test. Provided the air check valve disc and gasket are satisfactory, the pressure will go only as far as the air check valve when pressure is applied inside the case on the outward leak test. However, if there should be a defective air valve body gasket when suction is applied inside the case, a leak will be indicated as the air valve disc opens inward. A defective air valve body gasket would be replaced as shown in figure 6-5, in accordance with the disassembly of the air valve knob assembly.

An inward leak is more dangerous than an outward leak. An outward leak will only waste a little oxygen. At times there may be high concentrations of carbon monoxide in an aircraft. Inasmuch as a regulator is suction operated, it is possible to contaminate the air-oxygen mixture to the user. REGARDLESS OF THE TYPE, ALL LEAKS MUST BE REMEDIED

PERFORMANCE TESTS.—It is important that every regulator perform at peak efficiency. Some of the more common malfunctions, along with their causes and remedies, are listed in this section. These tests are to be made at the existing room temperature. No oil must be used around the oxygen equipment. All pressures should be applied as specified in the applicable manual for the regulator being tested. While performing these tests, the regulator must be positioned so that the diaphragm is in a vertical plane and the check valve, due to gravity, will have a tendency to open. Position all regulators so that the air valve knob assembly is on top.

EMERGENCY FLOW TEST.—The emergency flow test is performed to measure in l.p.m. the amount of oxygen flow delivered when the emergency valve is fully opened.

PROCEDURE FOR TESTING THE EMERGENCY FLOW ON THE 2858 SERIES REGULATORS:

1. Mount the regulator in the test stand.
2. Emergency valve must be closed.

3. Set inlet pressure as follows:
2858-A1, 2858-A1A,
2858-B1, and 2858-C1 at 100 p.s.i.

4. Open the outlet valve to an actual 50 l.p.m. flow on the output flowmeter.

5. Open the emergency valve slowly but fully.

6. Slowly close the outlet valve until a slight pressure is indicated on the pressure-suction manometer.

7. The emergency flow will be indicated on the output flowmeter. NOTE: Caution must be used in closing down the outlet valve. As the fluid approaches the 0 on the pressure-suction manometer, the emergency flow tends to override the remaining output flow and the manometer fluid rises very rapidly. After becoming accustomed to performing this test, it is usually the best policy to read the output flowmeter and the pressure-suction manometer simultaneously as the manometer fluid approaches zero.

8. In accordance with *Airframes Accessories Bulletin* 7-58, Oxygen Regulators 2858-A1, 2858-A1A, 2858-B1, and 2858-C1 all must deliver from 30 to 40 l.p.m.

9. Close the emergency valve first, then the outlet. The emergency valve assembly for the 2858 series regulators are identical in appearance. The only difference is that the orifice is larger in the B1 and C1. Ordinarily, the emergency valve assembly will not become interchanged during normal service of a regulator. If it should become changed by neglect in previous overhaul or repair, it must be corrected. Part numbers are marked on each assembly to identify the type. It is possible for these part numbers to become illegible. In this case, it will be necessary to perform the test for each type in order to determine the flow of the emergency valve assembly. If the B1 and C1 emergency valve assemblies are not available from supply, the orifice on the A1 and A1A emergency valve assemblies can be reamed larger. In all cases when an A1 and A1A emergency valve assembly is found, it must either be reamed larger in compliance with *Airframes Accessories Bulletin* 7-58, or replaced with a B1 and C1 emergency valve assembly.

CAUSES AND REMEDIES FOR INCORRECT EMERGENCY FLOW ARE:

LOW-EMERGENCY FLOW.

Cause: Obstructed or dirty orifice.

Remedy: Clean by blowing out with dry, oil-free air.

Cause: Clogged inlet screen.

Remedy: Clean or replace the screen.

Cause: Low inlet pressure.

Remedy: Reset the inlet pressure for the regulator being tested.

Cause: Leaking emergency valve assembly.

Remedy: Tighten stuffing box nut; replace packings.

HIGH EMERGENCY FLOW:

Cause: Damaged emergency valve orifice.

Remedy: Replace the emergency valve assembly.

Cause: High inlet pressure.

Remedy: Reset the inlet pressure for the regulator being tested.

If none of the listed causes are found to be the cause of a high or low flow, the emergency orifice is of improper dimension and the complete emergency valve assembly must be replaced.

The FLOW SUCTION TEST is performed to measure the amount of suction required to draw a specified flow through the regulator.

PROCEDURE FOR THE FLOW SUCTION TEST:

1. Mount the regulator properly in the test stand.
2. Emergency valve must be closed.
3. Position the air valve knob to 100 percent.
4. Apply 50 p.s.i. inlet pressure to the regulator.
5. Open the outlet valve and set the first corrected indicated flow on the output manometer. (Actual flows are given for this test from the manual. They must be converted to corrected indicated flows before starting the test.)
6. Record the suction reading on the performance worksheet.
7. Open outlet valve to the second corrected indicated flow. The inlet pressure must be readjusted each time there is a larger output flow set.
8. Record the suction reading on the worksheet.
9. Apply 150 p.s.i. inlet pressure to the regulator.
10. Open the outlet valve and set the third corrected indicated flow.
11. Record the suction reading on the worksheet.

12. Close the outlet valve and reduce the inlet pressure to 50 p.s.i.

13. Place the glass over the chamber.

14. Open the outlet valve to approximately 10 l.p.m. and ascend to 15,000 feet, using the bypass valve. The small flow set with the outlet valve is to relieve the pressure inside the regulator. With the air valve set to 100 percent, the only way to ascend to altitude is by using the bypass valve. If this small output flow was not set, the trapped pressure inside the regulator would expand at altitude and blow the fluid out of the pressure-suction manometer.

15. Close the bypass valve.

16. Repeat steps for flow suction test at altitude, setting the proper output flows by manipulating the outlet and inlet valves.

17. After the altitude flows are completed, descend to sea level by closing off the outlet valve to approximately 5 p.s.i. and opening the inlet valve further as necessary.

CAUSES AND REMEDIES FOR LOW SUCTION ARE:

Although low suction is not considered a serious malfunction, it should be corrected. Anything below 0.18-inch suction is low, even though it is not shown on the worksheet.

Cause: Weak demand valve spring. This will cause low suction because it will take very little effort to open the demand valve.

Remedy: Replace the demand valve spring with a stronger one.

Cause: Weak injector spring. This will cause low suction because the flow passing through the injector assembly will unseat the injector nozzle too soon, thus producing a greater flow of oxygen.

Remedy: Replace the injector spring with a stronger one.

CAUSES AND REMEDIES FOR HIGH SUCTION ARE:

This is probably one of the most frequent malfunctions that will occur while testing the performance of the regulators. IT IS A MALFUNCTION THAT MUST BE CORRECTED. High suction is dangerous, because it will tire the pilot at altitude.

Cause: Low-pressure reducer setting. This condition will require too much effort on the user to receive the required quantity of oxygen to sustain life.

Remedy: Reset the pressure reducer setting to 48 ± 1 p.s.i.

Cause: Stiff demand valve spring. The demand valve spring works against the bottom of the demand valve seat and holder keeping it seated. A stiff spring would cause too much suction to open the demand valve which passes the oxygen to the user.

Remedy: Replace the demand valve spring with a weaker one.

Cause: High-pressure reducer setting. This will act on the bottom of the demand valve seat retainer the same as having too strong a spring. Until the demand valve is opened, the flow of oxygen is stopped at the lower demand valve chamber.

Remedy: Reset the pressure reducer setting to 48 ± 1 p.s.i.

Cause: Stiff injector spring. Too much suction is required to unseat the injector nozzle to produce a larger flow of oxygen.

Remedy: Replace the injector spring with a weaker one.

Cause: Demand valve lever set too low. With the demand valve lever set too low, there is too much suction required to take up the excessive linkage to push the demand valve seat away from the demand valve.

Remedy: Reset the demand valve lever to 11/64 inch above the top edge of the regulator case.

Cause: Pressure reducer shutting off above horizontal. This condition would not leave enough space to contain the correct volume of oxygen, even though the pressure is correct. The user will unknowingly create excessive suction in order to receive the quantity of oxygen demanded.

Remedy: Reset the pressure reducer pin so that the hole is 9/64 inch above the surface of the bellows cap.

The ANEROID CLOSURE TEST is to determine at what altitude the aneroid shuts off the flow of air into the regulator.

PROCEDURE FOR THE ANEROID CLOSURE TEST:

1. Mount the regulator in the test stand.
2. Position the air valve knob to normal.
3. Apply 150 p.s.i. inlet pressure to the regulator.
4. Open the outlet valve to approximately 40 l.p.m.
5. Evacuate the test stand chamber until the altimeter stops. With the air valve knob positioned to normal, the air evacuated from the chamber is taken through the air valve. When the altimeter stops, the air valve is closed.
6. The aneroid must seat, closing the intake flow of air at not less than 28,000 feet, nor more than 32,000 feet. If the altimeter does not stop by the time it has reached 30,000 feet, reduce the output flow to 20 l.p.m. and observe the altimeter. If the altimeter does not increase more than 125 feet in 10 seconds, the air valve can be considered closed.
7. Close the outlet valve, open the inlet valve, and descend to sea level. With the air valve on normal, it is not necessary to have the bypass valve cracked.

CAUSES AND REMEDIES FOR THE ANEROID NOT CLOSING ARE:

Cause: Cocked aneroid.

Remedy: Replace the aneroid.

Cause: Scarred or dirty throttling plate and seat.

Remedy: Polish with 0000 polishing paper. Clean with Freon 113, and dry with clean, oil-free air. If the throttling plate is scarred too deep, it will necessitate replacement.

ANEROID AIR VALVE CLOSING TOO SOON:

Cause: Aneroid and throttling plate set too close to the seat.

Remedy: Loosen locknut and turn the aneroid threaded stem counterclockwise. One quarter turn equals approximately 2,000 feet.

ANEROID AIR VALVE CLOSING TOO LATE:

Cause: Aneroid and throttling plate set too far from the seat.

Remedy: Readjust the aneroid by turning clockwise.

This is a trial and error method, but it is the only way that the aneroid and air valve can be accurately set. After the first test to determine if the aneroid air valve is closing too soon or too late, it can usually be set correctly the next try with a little practice. An ideal aneroid air valve closure is 30,000 feet.

The OXYGEN RATIO TEST is performed to determine if the proper mixture of cylinder oxygen and air is being delivered to the user.

PROCEDURE FOR THE OXYGEN RATIO TEST:

1. Mount the regulator in the test stand.
2. Apply 150 p.s.i. inlet pressure to the regulator.
3. Position the air valve knob to normal.
4. Place glass over chamber and open the outlet valve to ascend to first test altitude.
5. Set the correct output flow specified and balance the altitude with the inlet valve.
6. Record the input flowmeter reading on the worksheet.

Keep in mind that the test stand was calibrated with air; therefore, it will only measure air. If the ratio of air is within the high and low limits, it is understood that the proper amount of oxygen is being delivered.

7. Repeat steps (5) and (6) at all altitudes until the ratio test is completed. For altitudes above that at which the aneroid air valve closes, the bypass valve must be used to ascend further.
8. Close the outlet valve, leaving the inlet valve open and descend to sea level.

CAUSES AND REMEDIES OF INCORRECT AIR-OXYGEN RATIO ARE:

High air at 5,000, 10,000, and 15,000 feet.

Cause: Weak check valve spring. With a weak check valve spring, too much air would be drawn in the air valve, diluting the oxygen at the venturi.

Remedy: Stretch the air check valve spring slightly.

Low air at 5,000, 10,000, and 15,000 feet.

Cause: Strong check valve spring. This will cause too much pressure against the air check valve disc, letting in too little air.

Remedy: Shorten the spring by cutting approximately 1/4 inch off one end.

Cause: Leaking injector assembly. This will allow excessive oxygen to enter the venturi, mixing with the air, and making the air content too low.

Remedy: Tighten the venturi over the injector assembly housing. If necessary, replace the injector seat and injector gasket.

High air at 20,000 feet.

Cause: Throttling plate too far from the housing seat. This is called excessive throttling plate movement. Without changing the setting of the aneroid air valve closure, which must close between 28,000 and 32,000 feet, the throttling plate must be adjusted to seat and start throttling (metering) air at approximately 20,000 feet.

Remedy: Loosen the plate retaining nut a few threads and place a drop of glyptal on the threads to prevent further loosening from vibration. If available, replace the plate retaining nut with one having a longer shoulder. Either of these remedies will place the throttling plate closer to the air valve housing seat. (See fig. 6-15.)

Low air at 20,000 feet.

Cause: Throttling plate too close to the housing seat. This is referred to as insufficient throttling plate movement.

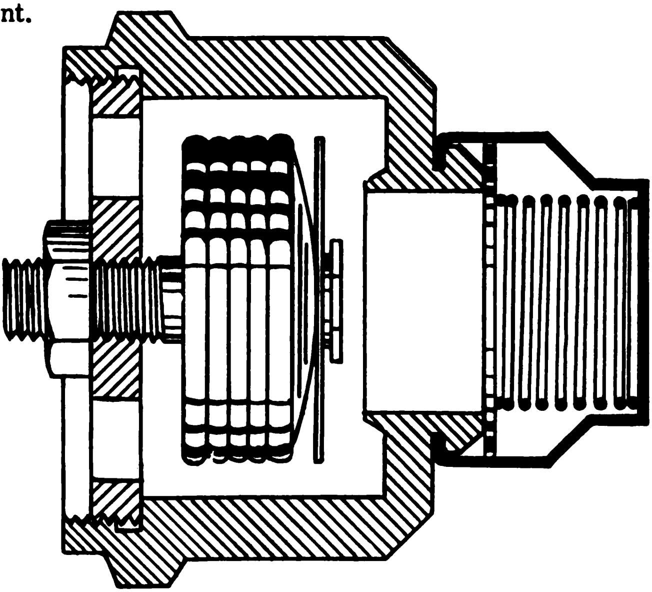


Figure 6-15.—Cutaway of air valve and throttling plate assembly.

Remedy: Replace the plate retaining nut with one having a shorter shoulder. By doing this, the throttling plate will have farther to travel before it seats.

Cause: Leaking injector.

Remedy: Tighten the venturi or replace the injector gasket.

High air at 25,000 feet.

Cause: Aneroid air valve closure too high. This will allow the aneroid and throttling plate both to travel too far before they seat. Too much air will enter the air valve at altitudes above 32,000 feet.

Remedy: Readjust the aneroid to close at 28,000 to 32,000 feet.

Low air at 25,000 feet.

Cause: Aneroid air valve closure too low.

Remedy: Readjust the aneroid to close at 28,000 to 32,000 feet

Cause: Strong air check valve spring against the air check valve disc.

Remedy: Clip off 1/4 turn of the air check valve spring.

Low and high air at 28,000 feet have the same causes and the same remedies as low and high air at 25,000 feet.

QUIZ

1. The diluter check valve in the air valve assembly
   a. allows the flow of 100 percent oxygen to the user
   b. prevents the escape of oxygen if the emergency valve is being used.
   c. opens outward during exhalation
   d. prevents escape of air-oxygen mixture on inhalation

2. To correct howling in the injector assembly, replace the
   a. injector spring with a stronger one
   b. injector spring with a weaker one
   c. injector nozzle
   d. damping spring

3. A 2858 regulator, air valve 100 percent, is indicating high suction. To correct this situation check the
   a. injector and aneroid
   b. pressure reducer and demand valve
   c. inlet valve and emergency valve
   d. air check valve and demand valve
4. Actual flows for converting air readings on the oxygen ratio test are found on the
   a. bottom of the output graph
   b. left side of the output graph
   c. bottom of the input graph
   d. left side of the input graph
5. It is necessary that the pressure reducer on a 2858 regulator shut off the flow when the lever is horizontal, or slightly below, so that
   a. enough pressure can be built up in the chamber
   b. the injector will unseat between 13 and 25 p.s.i.
   c. sufficient volume can be contained in the chamber
   d. the top of the pressure reducer will not hit the top of the chamber
6. The pressure in the pressure reducer on the 2858 regulator is adjusted to____ p.s.i. with____p.s.i. inlet pressure
   a. 56 ± 1; 150
   b. 48 ± 1; 150
   c. 56 ± 1, 100
   d. 48 ± 1; 100
7. A regulator with high suction characteristics would result in the user getting
   a. high air
   b. high oxygen
   c. high air and oxygen
   d. tired at higher altitudes
8. Excess space between the throttling plate and seat is a cause of
   a. low air at 10,000 and 15,000 feet
   b. high air at 20,000 feet
   c. low air at 20,000 feet
   d. high air at 10 and 15,000 feet
9. When performing the aneroid closure test on a diluter demand regulator, set the inlet pressure at____p.s.i. and open the_____valve.
   a. 300; outlet
   b. 300; bypass
   c. 150; outlet
   d. 150; inlet

10. The maximum allowable leakage for the outward leak test on the 2858 regulator is
    a. 8/10 l.p.m.; with 1-inch water pressure, air valve normal
    b. 3/10 l.p.m.; with 10-inch water pressure, air valve normal
    c. 1/2 l.p.m.; with 1-inch water pressure, air valve 100 percent
    d. 1 l.p.m.; with 10-inch water pressure, air valve 100 percent

11. To determine the actual high air for a specific flow, subtract the
    a. high oxygen percentage from 100, and multiply by the actual output
    b. low oxygen percentage from 100, and multiply by the actual output
    c. high oxygen percentage from 100, and multiply by the indicated output
    d. low oxygen percentage from 100, and multiply by the indicated input

12. In a regulator with inward leakage, but no outward leakage, the faulty part must be the
    a. check valve disc or seat
    b. bottom plate gasket
    c. diaphragm gasket
    d. air valve knife edge or knob gasket

13. The maximum allowable inward leakage on a 2858 regulator is
    a. 10 l.p.m. with 3-inch suction
    b. 1 l.p.m. with 1/2-inch suction
    c. 1/2 l.p.m. with 1-inch suction
    d. 1 l.p.m. with 10-inch suction

14. If, when testing a 2858 regulator for high-pressure leakage, the soap film over the injector stays while the film over the entire outlet extends, the leak originates in the
    a. inlet orifice gasket
    b. demand valve seat
    c. upper demand valve chamber
    d. all of the above

15. When testing for aneroid closure, if the aneroid has failed to stop completely, and continues to creep above 30,000 feet
    - a. open the inlet valve enough to stop the altimeter
    - b. close the outlet valve to 20 l.p.m. and time the increase in altitude
    - c. close the outlet valve until the altimeter stops, and read the output flowmeter
    - d. close the outlet valve to 20 l.p.m. and time the drop in altitude

16. The items required in order to prepare a performance check sheet for 2858 regulators consist of
    - a. input, output, and oxygen conversion graphs, and the manual for the 2858
    - b. input, output, and oxygen conversion graphs, and the calibration check chart
    - c. the calibration orifice, manual for the 2858, and the input graph
    - d. the manual for the 2858, calibration check chart, calibration orifice, and oxygen conversion graph

17. To test a regulator for inward leakage, after mounting it in the stand, turn the supply pressure
    - a. off, open the outlet valve, and read the output flowmeter
    - b. off, air valve 100 percent, apply 1-inch suction to the regulator outlet, and read the output flowmeter
    - c. on, air valve 100 percent, apply suction, and read the input flowmeter
    - d. none of the above
18. Low oxygen at 30,000 feet indicates that the aneroid failed to shut off due to
    - a. a leaky injector
    - b. a faulty check valve spring
    - c. excessive throttling plate movement
    - d. dirt on the throttling plate

19. When testing for flow suction characteristics, the maximum suction for the maximum flow is____ inch(es) of suction.
    - a. 0.75
    - b. 0.50
    - c. 1.50
    - d. 1.00

20. The pressure relief valve in the 2858 regulator allows a bleed off of excess pressure from the
    a. upper demand valve chamber
    b. pressure reducer chamber
    c. diaphragm chamber
    d. lower demand valve chamber

21. When testing regulators for high pressure leakage with soap film, the bubble should not extend more than____inch in 10 seconds.
    a. 1/16
    b. 5/16
    c. 7/16
    d. 3/16

22. The original setting for the 2858 regulator inlet valve is_____inch.
    a. 33/64
    b. 11/64
    c. 0.519
    d. 0.0519

23. To increase the throttling plate movement
    a. adjust the aneroid
    b. use a shorter retaining nut
    c. use a longer retaining nut
    d. loosen the plate retaining nut

24. With an actual 30 l.p.m. flow, and an allowable oxygen percentage of 0.01-0.30, the actual high and low air is
    a. 2.97-2.1 l.p.m.
    b. 21.0-27 l.p.m.
    c. 27.0-12 l.p.m.
    d. 29.7-21 l.p.m.

25. When performing a flow suction test on a 2858 type regulator, use
    a. 30, 40, and 85 l.p.m. below 15,000 feet
    b. 30, 40, and 70 l.p.m. above 15,000 feet
    c. 30, 40, and 70 l.p.m. below 15,000 feet
    d. 30, 40, and 85 l.p.m. above 15,000 feet

CHAPTER 7

REGULATOR MAINTENANCE -- CONTINUED

AUTOMATIC POSITIVE PRESSURE AND COMPOSITE DILUTER DEMAND OXYGEN REGULATORS

Automatic Positive Pressure Regulators

The automatic positive pressure diluter demand oxygen regulators, Pioneer-Central Types 2862, 2864, 2867, and 2873 are used in high-altitude flight to supply oxygen under pressure to the user. The regulator illustrated in figure 7-1 is the 2867-B1. It automatically mixes air and oxygen at a ratio which depends upon the altitude. The mixture is delivered to the user upon inhalation. A pressure breathing mask, such as the type A-13A, must be used with these regulators. With a tight mask, these regulators, supplying 100 percent oxygen, can be used up to 43,000 feet under normal conditions. Service ceilings may be exceeded by 2,000 feet for short periods in case of an emergency. At altitudes above approximately 34,000 feet, positive pressure is supplied to the user.

Although the 2867-B1 is the most widely used of this series of regulators, another model, designated as the 2867-A1B, is still used in some aircraft. The B1 differs from the A1B in that the B1 has been modified so that the flow indicator vents into the case, whereas the A1B vents to atmosphere. This modification allows the flow indicator to continue to operate at pressure breathing altitudes. Other than this change, the two regulators are

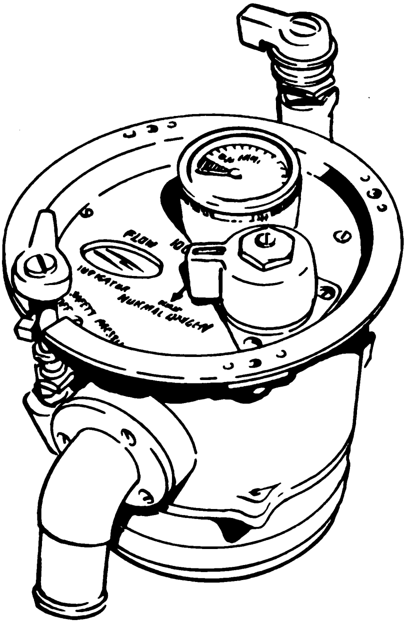


Figure 7-1.—Three-quarter view of automatic positive pressure diluter demand oxygen regulator, Pioneer-Central Type 2867-B1.

identical. A small hole can be seen on the case by the flow indicator on the A1B regulator.

Composite Regulators

Composite diluter demand regulators, Pioneer-Central Types 2863, 2872, and 2874 are also used for high-altitude flight. They have a service ceiling of 40,000 feet and are used with the A-13A pressure breathing mask. These regulators do not incorporate a pressure breathing back, otherwise they are identical in appearance to the automatic positive pressure regulators. Table 7-1 lists the components and features of both types.

Disassembly of Automatic Positive Pressure and Composite Diluter Demand Oxygen Regulators

Since disassembly of all of these regulators is a similar operation, only the step-by-step procedure for

Table 7-1.—Various components on the automatic positive pressure and composite diluter demand oxygen regulators.

Regulator	Pressure breathing	Push-pull safety press	Rotary safety press	Shut-off valve	Outlet
2862	x	x			Elbow
2863		x			Elbow
2864	x	x			Straight
2867	x		x	x	Elbow
2872			x	x	Elbow
2873	x		x		Elbow
2874			x		Elbow

disassembling the 2867 regulator is presented in this section.

The following special Bendix tools and test equipment are required:

Bendix Part Number	Nomenclature
QB70065-1	Wrench, Fixed Spanner
QB70737-5	Wrench, Piloted Spanner
QB70750-9	Wrench, Piloted Spanner
QB71259-1	Adapter, Pressure Gage
QB71260-1	Wrench, Hex Key
QB72025-1	Wrench, Slotted Socket
TQ-12-A	Wrench, Torque (0-150 inch-pounds)
TQ-50-A	Wrench, Torque (0-600 inch-pounds)
508	Gage (0-100 p.s.i.)
609	Key, T-Handle

REMOVAL OF BLINKER TUBE ASSEMBLY.—The blinker tube assembly is removed first in order to clear the flow tubes on the regulator inlet assembly. Remove the shield, and using a QB72025-1 wrench, take off the blinker tube, being careful not to damage the lead seals on each end of the tube.

DISASSEMBLY OF INLET AND SHUTOFF VALVE ASSEMBLY.—After removing the inlet valve assembly from the regulator case, place the inlet valve body in a vise. Using a 3/4-inch hexagon socket wrench equipped with a 3/8-inch drive and adapting it to the torque wrench TQ-50-A, remove the inlet valve assembly and the O-ring from the inlet valve body. Remove the retainer and sintered bronze filter assembly, being careful as the inlet valve assembly is spring loaded. Remove the compression spring, valve, seat insert, and O-ring from the inlet valve housing. Remove the shutoff valve assembly from the inlet valve body.

It is not necessary to disassemble the shutoff valve assembly unless repair or replacement is required. If disassembly is required, follow the order indicated by the index numbers 10 through 20 in figure 7-2. If the shutoff valve is disassembled, determine whether the seat on the valve and guide assembly is lead or nylon. These two different seats on the valve and guide assembly are not interchangeable. Never clean the sintered bronze filters contained in these regulators with any cleaning solvent. They are to be cleaned by reverse flushing with dry, clean, oil-free air.

REMOVAL AND DISASSEMBLY OF ANEROID AND CHECK VALVE ASSEMBLY.—After the air valve knob assembly has been removed from the top of the regulator case, remove the air valve screen and gasket. Using the fixed spanner wrench, Eclipse Pioneer No. QB70637-5, unscrew the aneroid and check valve assembly from its chamber in the regulator case. The aneroid and check valve assembly is now disassembled in the same manner as on the 2858 regulator, described in chapter 6.

REMOVAL AND DISASSEMBLY OF MOUNTING PLATE AND OXYGEN PRESSURE GAGE.—Remove the inlet tubing shield and loosen the pressure gage tubing at the inlet valve assembly. (See fig. 7-3.) Remove the safety pressure lever from the safety pressure shaft. If this is not done, the mounting plate cannot be removed. Take the six screws out of the mounting plate and remove the oxygen pressure gage tubing from the inlet valve assembly.

After removal of the mounting plate and oxygen pressure gage, place a piece of masking tape across the flow indicator dial to hold it in place within the oxygen flow indicator chamber. The oxygen pressure gage can be separated from the mounting plate by removing the two screws. The oxygen pressure gage tubing is soldered

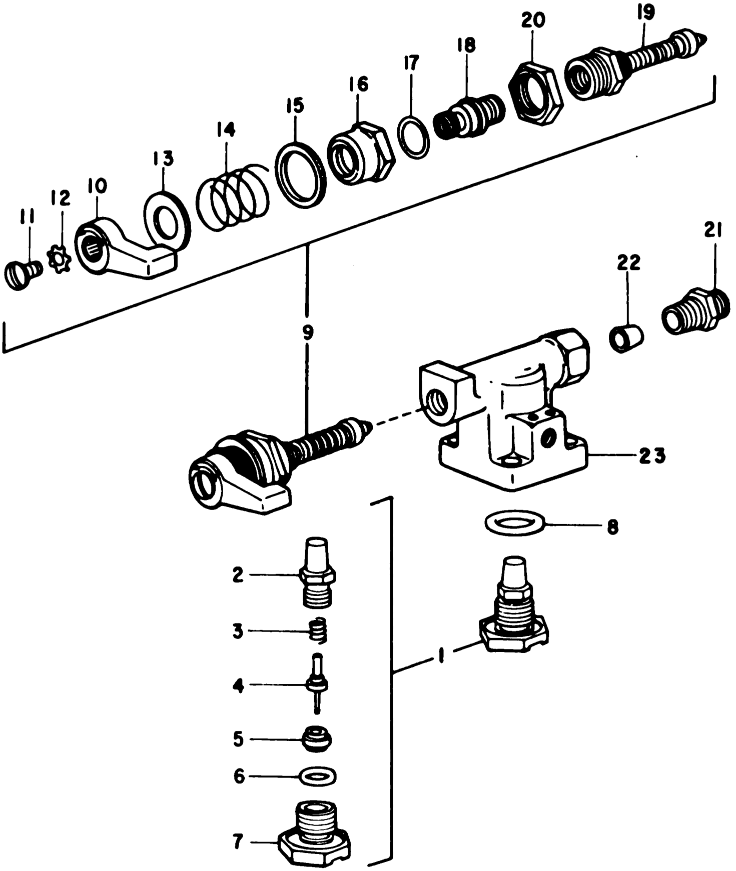


Figure 7-2.—Exploded view of inlet and shutoff valve assembly.

1. Inlet valve assembly.
2. Retainer and sintered bronze filter.
3. Compression spring.
4. Valve.
5. Seat insert.
6. O-ring.
7. Inlet valve housing.
8. O-ring.
9. Shutoff valve assembly.
10. Shutoff valve arm.
11. Screw.
12. External lockwasher.
13. Special washer, large.
14. Spring.
15. Special washer, small.
16. Shutoff valve stem stop.
17. Washer.
18. Actuating screw.
19. Valve and guide assembly.
20. Locknut.
21. Union nipple.
22. Sintered bronze filter.
23. Inlet valve body.

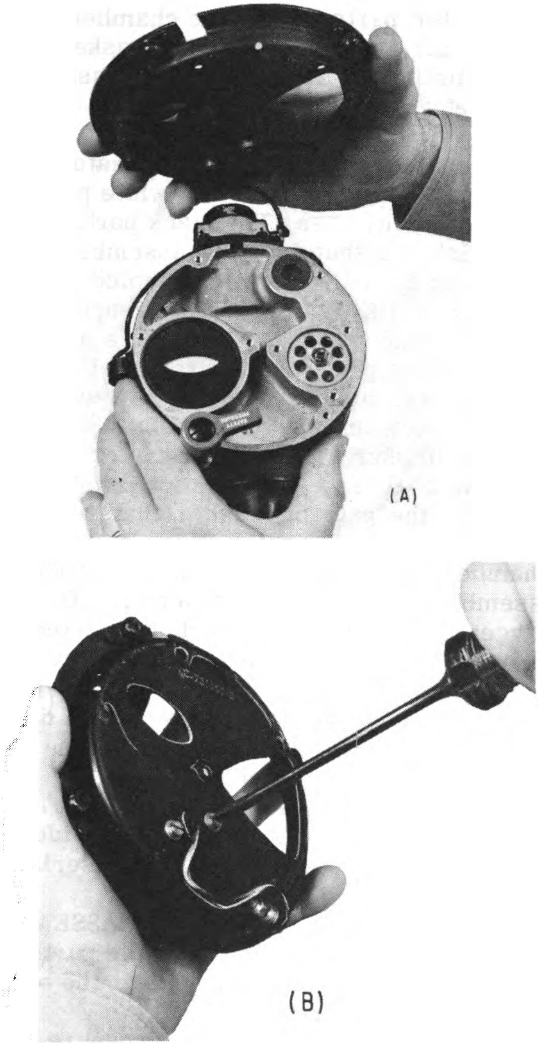


Figure 7-3.—Removal of mounting plate and oxygen pressure gage.

to the back of the oxygen pressure gage. Do not resolder this connection. If it is damaged, replace the entire oxygen pressure gage assembly.

REMOVAL OF OXYGEN FLOW INDICATOR ASSEMBLY.—Remove the masking tape that temporarily held the flow indicator parts within the chamber. As shown in figure 7-4, lift the glass dial and gasket off the two pins pressed into the case. It is not necessary to separate the gasket from the dial glass unless replacement of either part is required.

Before removing the oxygen flow indicator assembly, observe the position of the black and white portion of the plate in relation to the case. The black portion is located toward the inlet and shutoff valve assembly. The flow indicator assembly must be reassembled in the same position. Using the fixed pin spanner wrench QB70065-1, remove the retaining ring. Extreme care must be taken when using the fixed pin spanner wrench. If it is not positioned correctly, it will damage the lever and plate assembly of the flow indicator assembly.

Holding the blinker plate in the center of the case, remove the ring. Using tweezers or a jeweler's screwdriver, pry out the packing washer that rests between the frame and the flow indicator case. Lift the case out of the chamber. Figure 7-5 shows an exploded view of the disassembled flow indicator assembly. Disassembly of the oxygen flow indicator is not authorized. If it is damaged in any way, the entire flow indicator assembly must be replaced.

Airframes Accessories Bulletin No. 4-56, directs the installation of an improved dial glass seal and change in location of the vent in the flow indicator assembly chamber of the 2862 series, and types 2867-A1B and 2873-A1. Units that are modified are to be identified by the letter "B" stamped to the left of the serial number of the nameplate.

REMOVAL OF REGULATOR BACK ASSEMBLY.—In order to continue the disassembly of the parts mounted in the case, the assemblies attached to the back of the case must be removed first.

Remove the four screws in the pressure breathing housing assembly and lift from the regulator case. (See fig. 7-6.) Lift off the diaphragm gasket, then the diaphragm assembly. Further disassembly of the diaphragm assembly must not be attempted. Remove the screws and separate the housing from the plate and lever assembly. Loosen the screw and nut at the end of the ratio lever (long bar). This will be calibrated during reassembly.

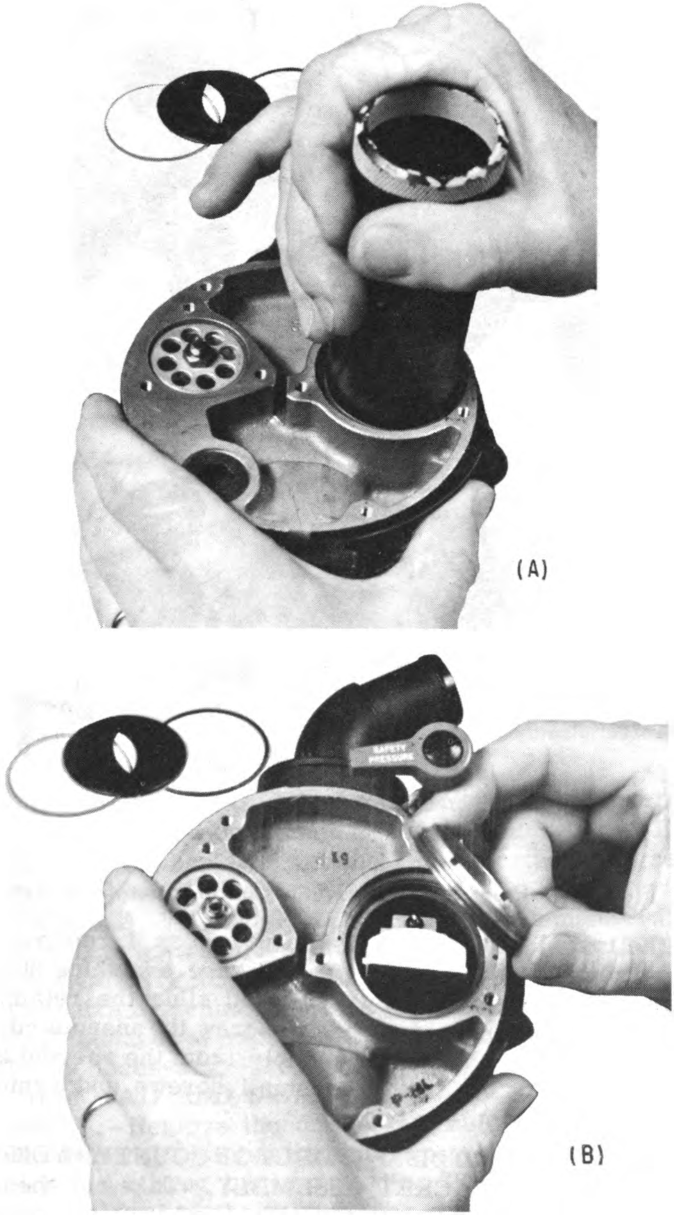


Figure 7-4.—Procedure for removal of flow indicator.

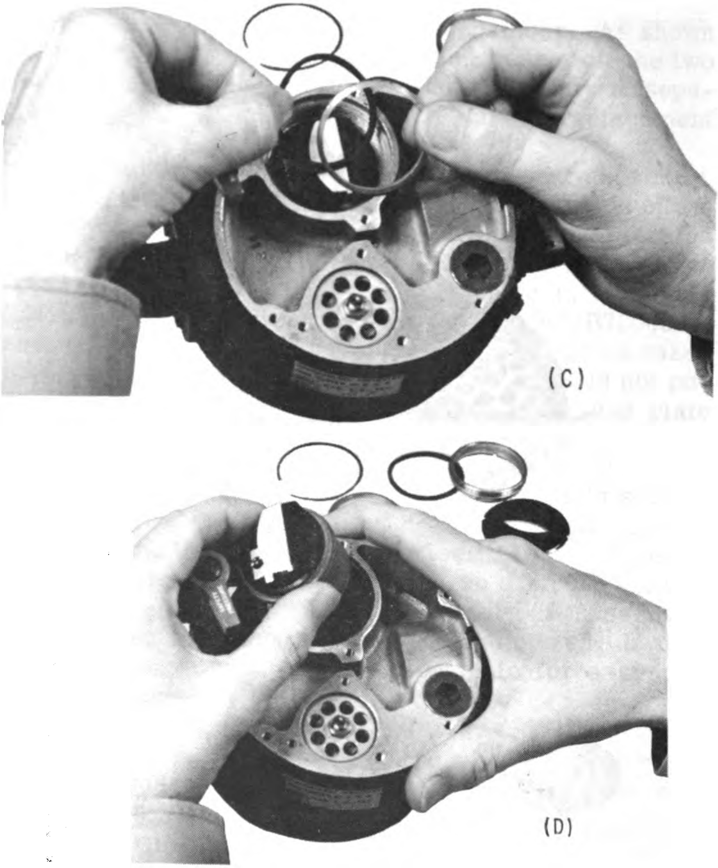


Figure 7-4.—Procedure for removal of flow indicator—Continued.

If the ratio lever has a long spring across it, remove the spring and replace it with a pressure breathing button (hex nut). Loosen the setscrew and slide the retaining strap over the aneroid cover. Unscrew the aneroid cover to separate the housing assembly from the aneroid assembly. Take out the three small screws and remove the aneroid from the cover.

REMOVAL AND DISASSEMBLY OF COUNTERWEIGHT LEVER AND BRACKET ASSEMBLY.—Take out the two screws that secure the counterweight and bracket assembly to the case and lift from the regulator case.

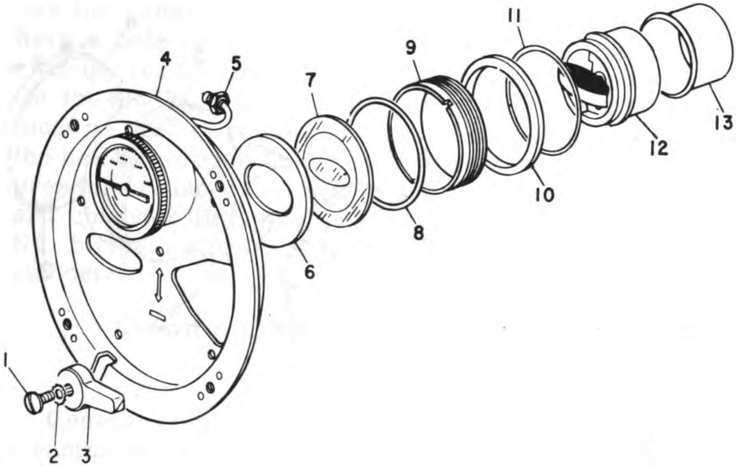


Figure 7-5.—Exploded view of mounting plate and flow indicator assembly.

1. Screw.
2. Lockwasher.
3. Safety pressure lever.
4. Mounting plate.
5. Oxygen pressure gage tubing.
6. Gasket.
7. Dial glass.
8. O-ring.
9. Retaining ring.
10. Ring.
11. Packing washer.
12. Flow indicator assembly.
13. Piston seal.

Airframes Accessories Bulletin No. 15-54, directs a new method for attachment of the counterweight. This modification, when accomplished, is indicated by a green dot on the case.

DEMAND VALVE ASSEMBLY.—The demand valve assembly is not removed. If damaged in any way, UNDER NO CIRCUMSTANCES will the Parachute Rigger attempt any repairs or replacements on the demand valve assembly. If damaged or replacement of any part of the demand valve is necessary, REPLACE THE REGULATOR.

REMOVAL AND DISASSEMBLY OF INJECTOR ASSEMBLY.—Remove the outlet and, using a wide-bladed screwdriver or piloted spanner wrench QB70750-9, unscrew the mixing tube (venturi on 2858) from the case. After removal of the mixing tube, slide out the injector assembly. Remove the injector gasket, using a pair of

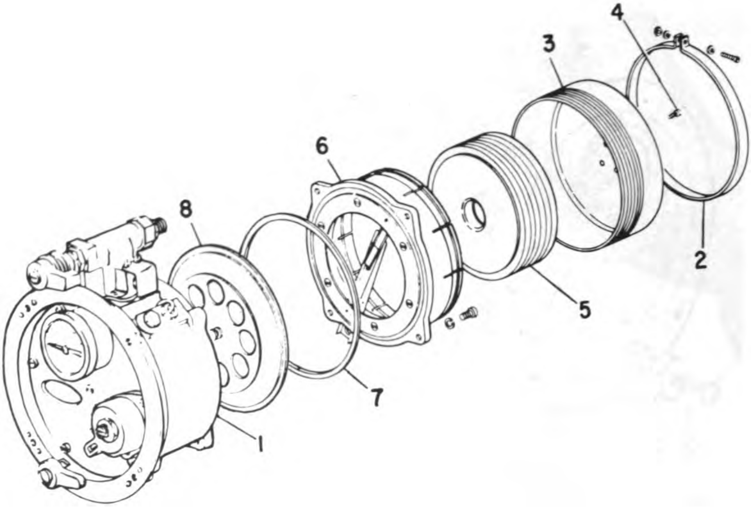


Figure 7-6.—Exploded view of diaphragm and pressure breathing back assembly.

1. Oxygen regulator stripped assembly.	5. Pressure breathing aneroid assembly.
2. Retaining strap.	6. Pressure breathing housing assembly.
3. Pressure breathing aneroid cover.	7. Diaphragm gasket.
4. Screw.	8. Diaphragm assembly.

tweezers. The injector assembly is now disassembled in the same way as the injector assembly on the 2858 regulator.

Airframes Accessories Bulletin No. 19-55 directs modifying the injector assembly with a new nozzle to eliminate fluttering in the aneroid and check valve assembly. Units modified are to have the letter "M" stamped before the serial number on the nameplate.

REMOVAL AND DISASSEMBLY OF PRESSURE REDUCER ASSEMBLY.—Using a 3/8-inch open-end wrench and the T-handle key wrench 609, loosen the pressure reducer nut (wrench 609 holds the stem). Take off the nut and two gaskets. Only on the 2867 and newer regulators can the T-handle key wrench be used. These regulators have a hole drilled through the case from the injector chamber for access to the pressure reducer bellows stem. On the older regulators the hex key wrench QB71260-1 must be used to remove the pressure reducer. Reinsert the hex key wrench or T-handle wrench and screw out the pressure reducer bellows. Remove the spring dampener and chamber liner from the pressure reducer chamber. No further disassembly of the pressure reducer is authorized.

Cleaning, Inspection, Reassembly, and Testing

General cleaning is essential after disassembly. For cleaning parts that must be washed, use Freon 113. Dry with clean, dry, oil-free air. Clean, dry, oil-free air is compressed air that has been compressed with a pump lubricated with water vapor. Any parts, such as gaskets, diaphragm, etc., made of rubber are never washed. Under no circumstances should oil or any lubricant be used on the regulator.

Inspection of the parts for scratches, misfits, dents, or any damage is done in accordance with the inspection of the parts given for the 2858 regulator.

DIAPHRAGM ASSEMBLY.—The diaphragm should be examined for cracks, tears, wrinkles, or signs of wear. Make sure it is tied tightly to the diaphragm ring. It must be slack enough so that when the diaphragm plates are assembled to the diaphragm and pressure is applied, the bottom of the fabric is flush or 1/16 inch below the diaphragm ring. If the diaphragm assembly does not meet these requirements, it must be replaced. At times the complete diaphragm assembly cannot be procured from the Supply Department. If this situation exists, it may be necessary for the Parachute Rigger to put a new diaphragm on the diaphragm ring. The procedure for replacing the diaphragm on the diaphragm ring follows:

Cut out the damaged diaphragm from the diaphragm ring. Using a small sable brush, coat the outer rim of the diaphragm ring with rubber cement, Pioneer-Central No. PB50810-1, as shown in figure 7-7. Vulcalock No. 4, manufactured by B. F. Goodrich Co., Akron, Ohio, may

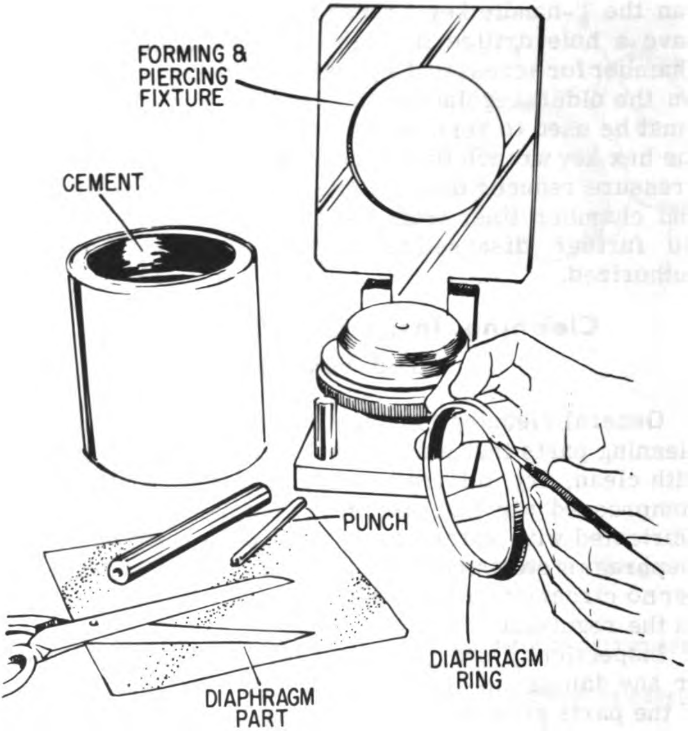


Figure 7-7.—Cementing of diaphragm ring.

be substituted for PB50810-1. Dry with a blast of clean, dry air. After drying, recoat the outer rim liberally and allow the cement to set.

Position the diaphragm piercing block QB72026-2 in the piercing and forming fixture QB72225-1. When the cement on the diaphragm ring has dried sufficiently to become tacky, place the diaphragm ring on the block. After placing the diaphragm squarely on top of the diaphragm piercing block, secure it in place with the O-ring as shown in figure 7-8. Press down the O-ring, which is supplied as part of the diaphragm piercing block, until it is seated in the groove provided for it in the base of the diaphragm piercing block.

With the diaphragm secured to the diaphragm piercing block (fig. 7-9), carefully smooth out all wrinkles,

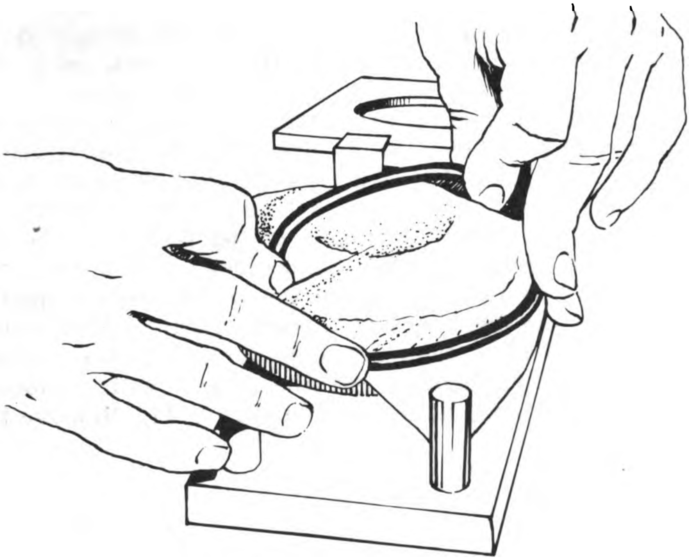


Figure 7-8.—Diaphragm forming operation.

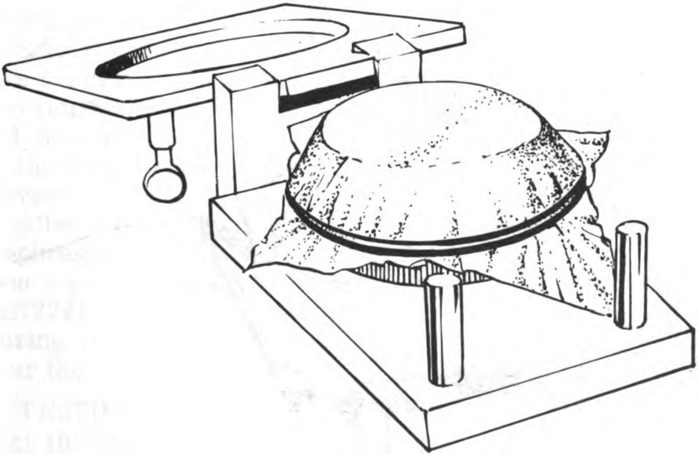


Figure 7-9.—Use of the O-ring.

particularly in the portion above the diaphragm ring. Apply a narrow band of cement to the diaphragm at the point where it is to be tied to the diaphragm ring, and lower the top of the piercing and forming fixture.

When the cement is tacky, secure the diaphragm winding thread PB50809-1 in the thread holding post which is visible in figure 7-10. This is done by making one complete turn around the thread holding post, seating the thread in the slot at the base of the post. Secure the thread by tightening the thumbscrew. Pass the free portion of the thread through the winding tube supplied as part of the piercing and forming fixture. Make three complete turns around the diaphragm. Tie the thread, using a square knot. Coat the thread with a liberal amount of cement as shown in figure 7-11. Remove the

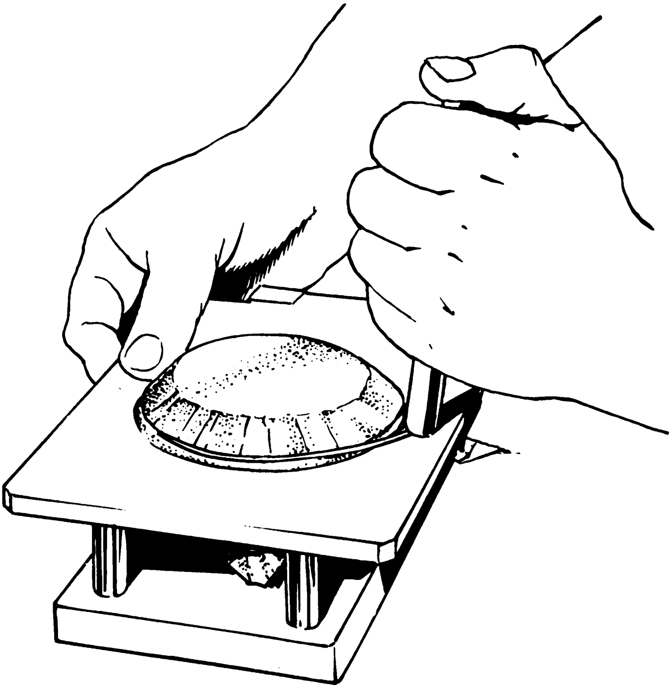


Figure 7-10.—Diaphragm tying operation.

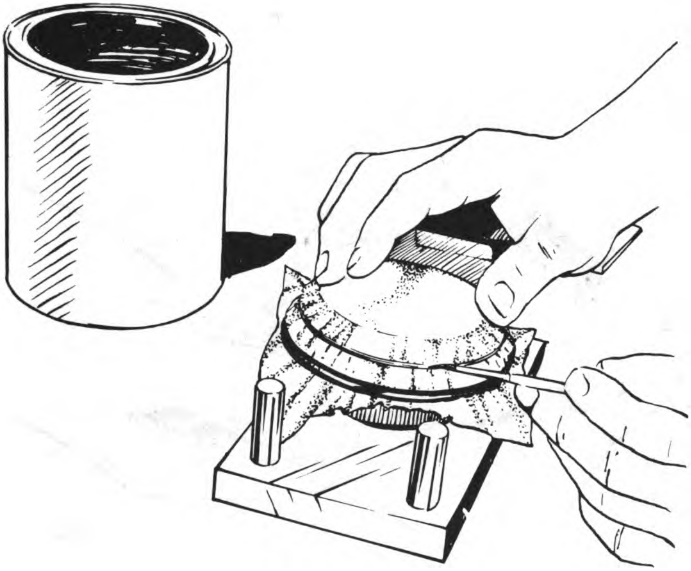


Figure 7-11.—Application of cement to thread winding.

O-ring and lift the diaphragm assembly from its position on the block.

Smooth out the wrinkles, as shown in figure 7-12, before the cement has dried sufficiently to make manipulation impossible. Carefully trim the diaphragm to within 1/8 inch of the winding as shown in figure 7-13. Turn up the edge so that it covers the winding following a neat selvage.

After the cement has dried thoroughly, mount the diaphragm assembly on the diaphragm piercing block. (See fig. 7-14.) Using the diaphragm piercing punch QB72224-2, carefully punch a hole in the diaphragm. During this operation, the punch must be held vertically over the apex of the block.

TESTING OXYGEN HIGH-PRESSURE GAGE.—Connect the tube and pressure gage assembly to a source of high-pressure oxygen (1,800 p.s.i.) to check the operation of the pressure gage. Check the pressure gage on decreasing pressures at 1,500, 1,000, and 500 p.s.i. It must read correctly within plus or minus 75 p.s.i.

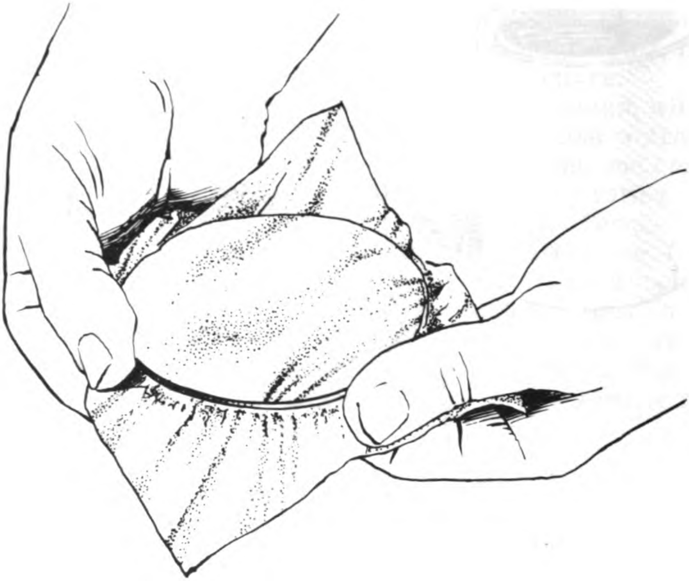


Figure 7-12.—Smoothing out wrinkles.

REASSEMBLY OF INLET AND SHUTOFF VALVE ASSEMBLY.—Insert the O-ring, seat insert, valve, and compression spring in the inlet valve housing in the order shown in figure 7-2. Using torque wrench TQ-12-A, and a 3/8-inch socket, tighten the retainer and filter assembly to a torque of 30 to 40 inch-pounds. Using torque wrench TQ-50-A, and a 3/4-inch socket, tighten the inlet valve assembly into the inlet valve body to specified torque. (B1—125 inch-pounds. A1—300 inch-pounds.) Use of greater force may turn the head off the seat. Install the sintered bronze filter and the union nipple in the inlet valve body.

Apply a small amount of Dow Corning DC-7 to the outer threads of the valve and guide assembly. Place the locknut on the valve and guide assembly. Apply a small amount of Dow Corning DC-7 to the threads and install the actuating screw in the valve and guide assembly. Install the shutoff valve assembly in the inlet valve body. Slip the shutoff valve arm over the serrations of the

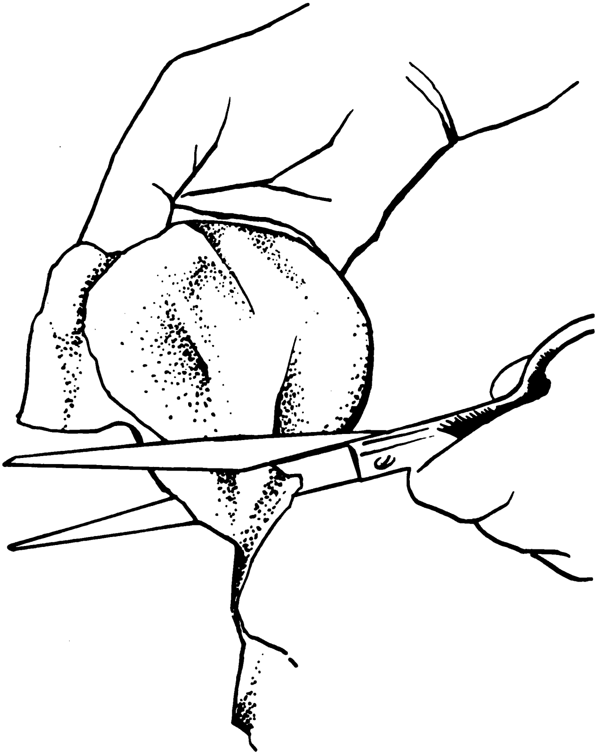


Figure 7-13.—Trimming diaphragm assembly.

actuating screw. Using the shutoff valve arm for leverage, tighten the actuating screw finger tight. After the actuating screw is tight, relocate the shutoff valve arm to the OFF position, as shown in figure 7-15. Open the shutoff valve by turning the shutoff valve arm counterclockwise approximately 200 degrees. Lift off the shutoff valve arm, being very careful to leave the actuating screw in the same position. Install the washer in the shutoff valve stem stop. Using two wrenches, tighten the shutoff valve stem stop and the valve and guide assembly locknut.

After the assembly has been tightened, check the rotation of the shutoff valve arm from OFF to ON. There should be approximately 200 degrees inboard rotation.

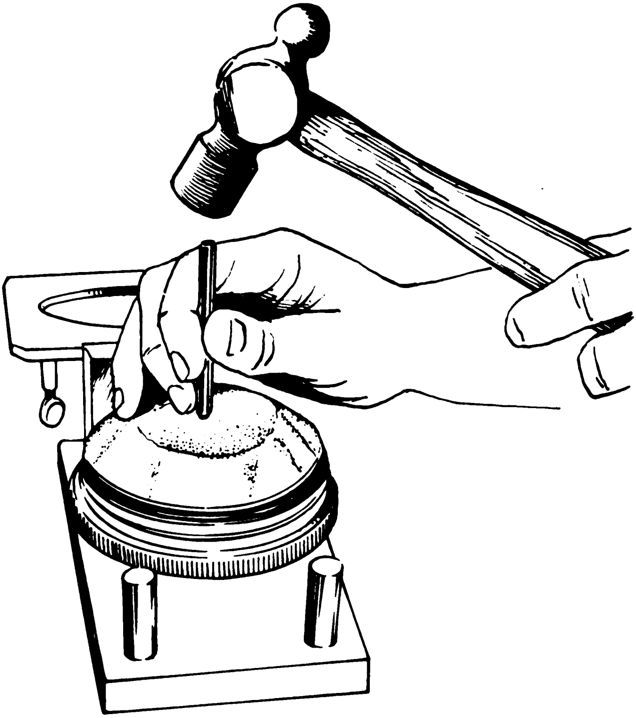


Figure 7-14.—Piercing operation.

It is important that the rotation be inboard, as the mounting of this regulator in some aircraft will not allow an outboard rotation. Install the small special washer, the spring, the large special washer, and the shutoff valve arm to the valve and guide assembly. Secure the shutoff valve arm with the screw and external lockwasher.

TESTING INLET AND SHUTOFF VALVE ASSEMBLY.—After the inlet and shutoff valve assembly has been reassembled, the following test must be performed. Apply a small amount of thread lubricant MIL-T-5542B (antiseize compound) to the pipe threads of the union nipple. Connect the inlet and shutoff valve assembly to a controllable source of oxygen and apply 1,600 to 2,000 p.s.i. through the union nipple and dip the assembly into a container of water. There must be no leakage which

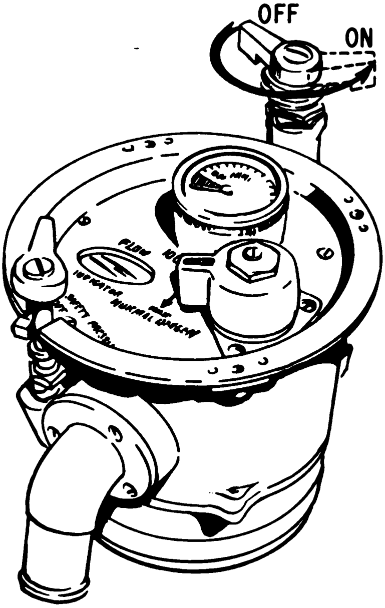


Figure 7-15.—Position of shutoff valve arm.

would be indicated by bubbles. Turn off the pressure and release the 1,600 to 2,000 p.s.i. pressure in the line. Apply 50 p.s.i. pressure, and repeat the test. There must be no leakage.

INSTALLING THE PRESSURE REDUCER ASSEMBLY.—Scribe a mark on the case aligning the hole in the case that goes to the lower demand valve chamber with one of the holes in the pressure reducer chamber liner. Insert the pressure reducer assembly into the threaded hole in the case.

Using the T-handle key, or appropriate tool as shown in figure 7-16, screw the pressure reducer assembly into the case. When there are enough threads showing on the inside of the case, assemble the two gaskets and start the pressure reducer stem nut. Place the pressure reducer dampener into the slot in the pressure reducer

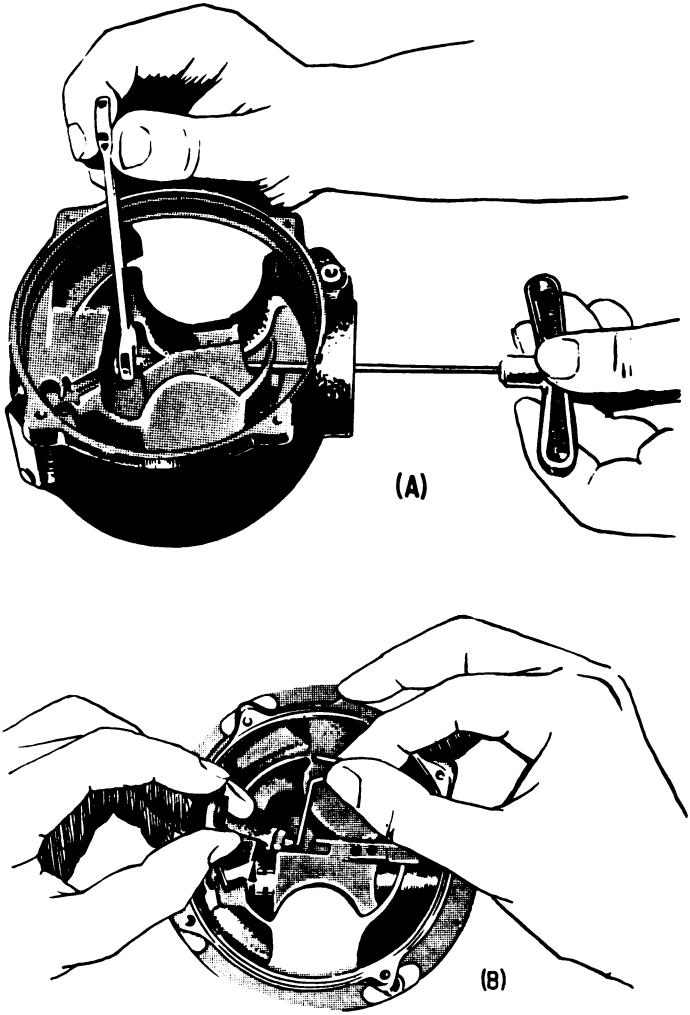


Figure 7-16.—Methods of adjusting the pressure reducer assembly.

(A)

Adjusting the pressure reducer assembly using T-handle key No. 609 for 2867, 2872, 2873 and 2874 regulators.

(B)

Adjusting the pressure reducer assembly using hex key wrench QB71260-1 for 2862, 2863 and 2864 regulators.

assembly. Carefully insert the widest end of the pressure reducer chamber liner in the case and around the pressure reducer assembly. Be sure that one of the holes in the pressure reducer assembly chamber liner is aligned with the scribe mark on the case. If this is not done, there will be a restricted flow of oxygen to the demand valve chamber.

Hold the pressure reducer nut with an open-end wrench as shown in figure 7-16. Turn the pressure reducer assembly with the T-handle key counterclockwise until the top of the bellows is below the top of the case. On a flat smooth surface, press the pressure reducer chamber liner flush with the case. Be sure the liner is flush with the case and the pressure reducer dampener is properly seated. Tighten the pressure reducer stem nut.

Install the gasket, and secure the inlet and shutoff valve assembly to the case with four screws.

ADJUSTING THE PRESSURE REDUCER ASSEMBLY.—Close off the high-pressure gage hole in the inlet valve. Attach the pressure gage adapter QB71259-1 to the hole provided in the side of the case on the pressure side of the demand valve chamber. Attach a 0-100 pound gage to the gage adapter. Connect the regulator union to a controllable source of oxygen. Adjust the inlet oxygen pressure to 100 p.s.i. Loosen the pressure reducer stem nut with an open-end wrench. Using the T-handle key, adjust the pressure reducer stem screw until the gage reads between 55 and 65 p.s.i., as shown in figure 7-16. The pressure is usually set at an average of 60 p.s.i. If the pressure is below 55 p.s.i., turn the pressure reducer stem screw clockwise with the T-handle key. If the pressure is above 65 p.s.i., turn the pressure reducer stem screw counterclockwise. When the proper adjustment is obtained, lock the pressure reducer stem screw by holding it in place with the T-handle key and tightening the pressure reducer nut with the open-end wrench.

Apply soap solution around the plug and pressure reducer nut. Check for leaks around these parts. There must be no signs of leakage. Make several checks by lifting the demand valve lever assembly. Remove all traces of soap solution from the parts.

DEMAND VALVE AND INLET VALVE LEAK TEST.—With the pressure of 100 p.s.i. still applied to the inlet and shutoff valve assembly, draw a soap film over the injector opening. There must be no leakage, as indicated by expansion of the soap film. If a leak is indicated, observe the pressure on the pressure gage. If the gage shows a steady rise of pressure above the pressure reducer setting, a leaking inlet valve is indicated. Replace the inlet valve assembly.

ADJUSTING DEMAND VALVE LEVER.—Use a lever setting gage, if available. With the pressure of 100 p.s.i. still applied to the inlet and shutoff valve assembly, hold the lever setting gage across the back of the regulator case. Position the end of the lever setting gage over the end of the demand valve lever assembly, as shown in figure 7-17. Adjust the setscrew until the demand valve lever assembly just touches the lever setting gage. Turn off the oxygen supply and disconnect the regulator.

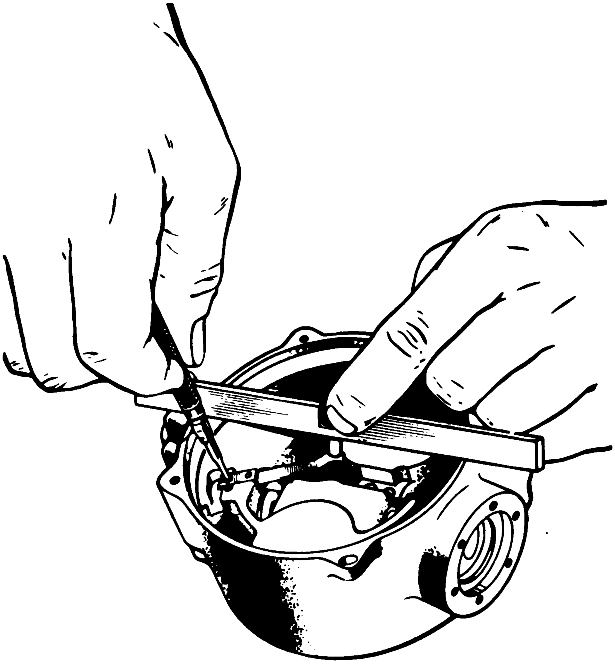


Figure 7-17.—Adjusting demand valve lever.

In case a lever setting gage is not available, the following method may be used for adjusting the demand valve lever: Hold a straightedge across the back of the regulator case. Position a scale perpendicular to the straightedge over the demand valve lever. Adjust the setscrew in the demand valve lever to measure 33/64 inch from the tip of the demand valve lever to the end of the scale.

INSTALLING COUNTERWEIGHT LEVER AND BRACKET ASSEMBLY.—The counterweight lever and bracket assembly is replaced in the reverse order of removal. Make certain that *Accessory Bulletin No. 15-54* has been complied with. The counterweight lever and bracket assembly must move freely in the recess in the case. The function of the counterweight lever and bracket assembly is to insure proper performance of the regulator when the aircraft is involved in violent maneuvers.

REASSEMBLY AND INSTALLING INJECTOR ASSEMBLY.—The older type injector assemblies are reassembled in reverse order of disassembly. This injector assembly is practically identical to the injector assembly for the 2858 regulator. The slot in the injector housing and the slot in the air valve must match when the injector assembly is positioned. It is secured in the case with the mixing tube by using the piloted spanner wrench QB70750-9. The mixing tube should be screwed in tightly to insure firm seating of the injector assembly against the gasket.

The injector assembly for the 2867-B1 is an advanced design and is reassembled as follows:

Place the gasket on the injector assembly. Place the O-ring on the injector piston. Insert the injector piston with the O-ring and the compression spring in the injector assembly.

Position the injector assembly, using the Bendix spanner wrench and the index finger as a guide. (See fig. 7-18.) The slot in the injector must be aligned with the hole in the case that leads to the air valve chamber. If these holes are not aligned, there will be a restricted flow of air into the mixing tube. This condition will be indicated by showing a low air reading on the oxygen ratio test. Lock the injector assembly in this position by screwing in the mixing tube, using the piloted spanner wrench QB70750-9.

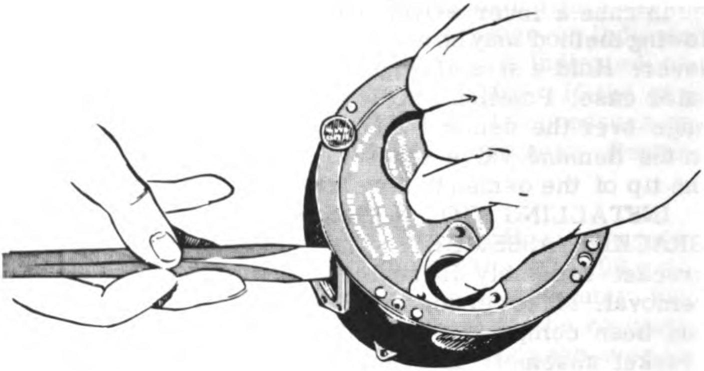


Figure 7-18.—Positioning the injector housing.

TESTING INJECTOR ASSEMBLY.—Connect the inlet and shutoff valve assembly to a controllable source of oxygen. Apply 150 p.s.i. pressure. Fully depress and release the demand valve lever several times to check the injector for vibration. If the injector assembly howls, the damping spring must be replaced. Secure the oxygen pressure to the regulator and remove the pressure from the regulator by depressing the demand valve lever.

REPLACEMENT OF SAFETY PRESSURE MECHANISM.—If the safety pressure shaft was removed, replace the shaft and tighten the setscrew in the case. Install the spring seat and the spring on the screw. Install the nut and locknut on the screw. Attach these parts to the bottom of the safety pressure shaft assembly. Make certain that the screw is secured in the shaft all the way.

REASSEMBLING DIAPHRAGM AND HOUSING ASSEMBLIES.—Hold the diaphragm assembly so that the diaphragm plate is facing downward. Depress the diaphragm screw and engage it with the U-portion of the counterweight lever and bracket assembly. Install the gasket in the case. Set the clamp in the long arm 7/32 inch from the center of the screw to the outboard end of the slot. Position the pressure breathing housing assembly so that the long lever is over the safety pressure opening in the case adjacent to the injector assembly. Secure the housing assembly, using the screws and the lockwashers. Fasten the pressure breathing aneroid assembly inside the aneroid cover with the screws. Screw the aneroid cover into the housing assembly all the way, and back off a turn or so. Do not lock the pressure breathing aneroid assembly in place with the strap. The pressure breathing aneroid has to be calibrated in the test stand before the strap is locked.

INSTALLING OXYGEN FLOW INDICATOR ASSEMBLY.—Carefully pull the piston seal (fig. 7-5) over the oxygen flow indicator assembly. Place the assembly in the case so that the black portion of the blinker plate moves away from the inlet and shutoff valve assembly when it operates. Position the oxygen flow indicator assembly so that the center line of the blinker plate is aligned evenly across the chamber in the case. Install the packing washer and ring. Using fixed spanner wrench QB70065-1, secure the retaining ring. Install the O-ring, dial glass, and gasket. Temporarily place a piece of masking tape over the dial glass to hold it in the case.

INSTALLING MOUNTING PLATE AND OXYGEN PRESSURE GAGE ASSEMBLY.—Install the plug, O-seal lock, and screw in the case where the 0-100 pound pressure gage was installed. Using the slotted socket wrench, secure the screw. Place the slot in the mounting plate and oxygen pressure gage assembly under the safety pressure shaft. Remove the masking tape from the dial glass. Carefully align the screw from the gage assembly with the opening in the inlet and shutoff valve assembly. Turn the screw in a few threads, and then secure the mounting plate and oxygen pressure gage assembly to the case with the screws provided. Tighten the screw on the oxygen pressure gage tube. Install the blinker tube assembly. Using the slotted socket wrench, tighten the screws. Install the tube shields. Install the tube filter, gasket, elbow assembly, retainer plate, and safety pressure arm; secure them with the screws. Attach the sealing cap.

REASSEMBLY AND INSTALLING ANEROID AND CHECK VALVE ASSEMBLY.—Secure the aneroid assembly to the aneroid housing cover, using the nut. Secure the throttling plate and the spring washer to the aneroid assembly. Be sure there are no scratches or nicks on the throttling plate. Attach the aneroid housing to the aneroid housing cover.

As a preliminary adjustment, turn the aneroid assembly in the aneroid housing until the throttling plate is about 1/8 inch above the seat in the aneroid housing. Lock the aneroid assembly at this adjustment by tightening the nut. This preliminary adjustment is an aid in making the final adjustment which is made during the aneroid closure test. If the results of the tests meet the requirements, no further adjustment is necessary.

Attach the spring adapter assembly to the aneroid check valve retainer assembly. On this regulator, the spring tension is adjusted by a small setscrew in the spring retainer. Insert the aneroid check valve spring and the check valve disc in the aneroid check valve retainer assembly. Spread the prongs of the aneroid check valve retainer assembly just enough to seat it on the aneroid housing. Using the fixed spanner wrench QB70637-5, screw the aneroid and check valve assembly into its chamber in the regulator case. Place the screen, gasket, and the air valve knob on top of the aneroid assembly and secure to the case with three screws.

Test Procedure

The composite and automatic positive pressure diluter demand regulators, like the 2858 regulator, must undergo and pass rigid leak and performance tests. If a regulator does not perform properly, it may cause injury or death to flight personnel. It is the Parachute Rigger's job to insure that service regulators perform properly at all times. Table 7-2 shows a suitable worksheet for all the tests required for these regulators. All leaks must be remedied before proceeding to the performance tests.

Unless otherwise specified, tests must be performed at an atmospheric pressure of 29.92 inches of mercury and at a room temperature of approximately 77° F. If test conditions are materially different from these, allowances must be made. Unless otherwise specified, all tests are to be conducted with the external oxygen supply valve fully open. After completion of the oxygen regulator tests, disconnect the tube from the outlet and close the external supply valve. Remove the pressure from the inlet to the regulator. Rotate the safety pressure knob to ON, relieving the trapped oxygen from the regulator through the outlet.

Table 7-2.—Performance check worksheet for composite and automatic positive pressure diluter demand regulators.

REGULATOR PERFORMANCE CHECK SHEET

2862, 2863, 2864, 2867, 2872, 2873, 2874 A1, A1B & B1

Date________ Regulator Type ________ Test stand No. ________

Operator________ Regulator serial No. ________

1. High-pressure leak ________
   Flow indicator leak ________
2. Overall leak ________
3. Shutoff valve leak ________
4. Outward leak normal ________
   Outward leak 100 percent ________
5. Inward leak ________
6. Flow suction test (100 percent) ________

Altitude	Inlet pressure	Actual output	Indicated output	Corrected indicated output	Maximum suction	Suction
Sea Level	50	30			0.45	
Sea Level	50	40			0.75	
Sea Level	150	70			1.50	
15,000	50	30			0.45	
15,000	50	50			0.75	
15,000	150	85			1.50	

7. Aneroid air valve closure ________ altitude
8. Oxygen ratio test (normal)

Table 7-2.—Performance check worksheet for composite and automatic positive pressure diluter demand regulators—Continued.

Altitude	Oxygen percent	Percent average	Actual output	Indicated output	Corrected indicated output	Actual		Indicated		Reading
						HI	LO	HI	LO	

9. Pressure breathing test

Altitude	10 L.P.M.	Minimum pressure	Maximum pressure	Reading

10. Safety pressure test 10 L.P.M. __________ Pressure drop 50 L.P.M. __________

Be sure all parts of the regulator and all equipment used for testing are absolutely free from oils and grease or any other material that is not approved for use in the presence of high-pressure oxygen. The presence of oil or grease may cause spontaneous combustion and explosion.

PRETESTING.—Before individual tests are made, it is recommended that all regulators be cycled for 30 minutes at approximately 20 l.p.m. with an inlet pressure of 200 p.s.i. and the air valve on NORMAL. This check is performed to show up defects in the regulators that may be the result of improper assembly.

HIGH-PRESSURE LEAK TEST.—The high-pressure oxygen leak test is performed to determine whether or not the parts inside the regulator are leaking. A leak is indicated by a bubble appearing when a film of soapy water is applied to the regulator outlet. The high-pressure leak test is performed as described for the 2858 regulator. With the safety pressure in the OFF position, apply pressures of 50, 150, and 1,800 p.s.i. to the inlet of the regulator. There must be no leakage indicated when a soap film is drawn over the outlet.

CAUSES AND REMEDIES OF HIGH-PRESSURE LEAKAGE ARE:

Cause: Leaking inlet valve.

Remedy: Remove the inlet valve assembly and test by dipping in a container of water. If bubbles appear around the pin, rebuild the inlet assembly and replace the pin. If bubbles show around the valve on the A1, tighten it to 300 inch-pounds and 125 inch-pounds on the B1.

Cause: Pressure reducer set too high or too low.

Remedy: Reset the pressure to 55-65 p.s.i.

Cause: Leak in the pressure reducer bellows.

Remedy: Replace the pressure reducer bellows.

Cause: Leak around the pressure reducer nut.

Remedy: Replace the packings and tighten the pressure reducer nut.

Cause: Weak demand valve spring.

Remedy: Replace the regulator. The demand valve acts as the pressure safety release on these regulators. Instead of the seat of the demand valve being pushed away from the valve as on the 2858, the seat is lifted away from the valve. With the pressure working on the seat of the demand valve, a weak demand valve spring would allow an escape of oxygen through the valve, even though the pressure reducer is set correctly.

As mentioned before, disassembly of the demand valve on the composite and automatic positive pressure diluter demand regulators is not authorized except at a major overhaul station. The only possible remedy then for a weak demand valve spring would be to turn the regulator in to the Supply Department for major overhaul.

Cause: No play in the long bar (ratio lever) or pressure breathing back.

If this condition exists, the long bar would be exerting pressure on the counterweight and bracket assembly. The bracket assembly, through linkage, depresses the diaphragm button, lifting the seat away from the demand valve.

Remedy: Readjust the safety pressure so there is a slight play between the end of the shaft and the long bar.

Cause: Demand valve lever set too high.

Remedy: Reset the demand valve lever so that it is 33/64 inch below or inside the bottom edge of the case. Use the lever setting gage if available; otherwise, use a straightedge and scale, as previously described.

FLOW INDICATOR LEAK TEST.—For regulators that have not been modified in accordance with *Airframes Accessories Bulletin No. 4-56,* the following flow indicator leak test is performed.

With the inlet pressure still applied to the regulator from the high-pressure leak test, depress the safety press and soap the flow indicator vent tubing and tubing connections. There must be no leakage indicated.

For B1 regulators and regulators that conform with *Airframes Accessories Bulletin No. 4-56,* the following flow indicator leak test is performed:

The purpose of a different test on these modified regulators is that the flow indicator is vented into the case instead of to the atmosphere.

1. Remove the flow indicator plug from the boss (for remote mounting), and install a high-pressure fitting.
2. Remove blinker tube and plug the hole leading into the flow indicator chamber.
3. Apply 25 p.s.i. to the high-pressure fitting that was installed in the flow indicator boss.
4. Draw a soap film over the outlet of the regulator. There must be no evidence of a leak.

CAUSES AND REMEDIES FOR FLOW INDICATOR LEAKAGE ARE:

Cause: Leaking piston seal or flow indicator gasket.

Remedy: Replace the piston seal. Tighten or replace the gasket.

Cause: Leaking flow indicator line.

Remedy: Tighten the fitting of the line or replace if necessary.

Cause: Improperly positioned spacer.

Remedy: Reposition spacer directly under retainer ring and retighten.

SHUTOFF VALVE LEAK TEST.—The shutoff valve leak test is performed only on the 2867 and 2872 regulators. With the safety pressure rotated to the ON position and the shutoff valve closed, apply 1,800 p.s.i. inlet pressure. With a soap film drawn over the outlet, there must be no evidence of leakage.

CAUSES AND REMEDIES OF SHUTOFF VALVE LEAKAGE ARE:

Cause: Marred shutoff valve seat.

Remedy: Replace the shutoff valve.

OVERALL LEAK TEST.—The overall leak test is also performed only on the 2867 and 2872 regulators.

With the 1,800 p.s.i. inlet pressure still applied for the shutoff valve test, rotate the safety pressure to the OFF position. Open the shutoff valve and the 1,800 p.s.i. will register on the high-pressure oxygen gage. Close the shutoff valve and remove the regulator from the pressure source. The pressure indicated on the high-pressure gage must not drop more than 100 p.s.i. in 2 minutes.

The causes and remedies for the overall leak test are the same as for the high-pressure leak test.

INWARD LEAK TEST.—The inward leak test is performed the same as was described for the 2858 regulator. The allowable leakage is 0.5 l.p.m. registered on the output flowmeter. If the OTS 565 (NIL) test stand is being used, any rise of fluid on the output flowmeter would indicate leakage.

Causes and remedies for inward leakage are the same as for the 2858 regulator.

FLOW SUCTION TEST.—In order to perform the flow suction test it will be necessary to complete the flow-suction block of the performance worksheet shown in table 7-2. The altitudes, inlet pressures, actual outputs, and maximum suctions are given in the appropriate manual.

CAUSES AND REMEDIES FOR HIGH SUCTION ARE:

Cause: The pressure reducer pressure set too low.

Remedy: Reset the pressure to 55-65 p.s.i.

Cause: Pressure reducer liner installed upside down, which would cause a restricted flow to the demand valve.

Remedy: Invert the pressure reducer liner. Be sure that the liner is inserted with the large side first.

Cause: Low setting of the diaphragm lever.

Remedy: Reset the diaphragm lever to 33/64 inch below the edge of the regulator case.

Cause: Excessive back pressure from the injector assembly.

Remedy: Replace the injector spring with a weaker one.

The causes and remedies for low suction are the same as for the 2858 regulator.

ANEROID AIR VALVE CLOSURE TEST.—The procedure for the aneroid air valve closure test is the same as for the 2858 regulator. Also, the causes and remedies for the aneroid not closing, closing too early, or too late are the same.

OXYGEN RATIO TEST.—The oxygen ratio test is to determine if the proper mixture of cylinder oxygen and air is being delivered to the user. Oxygen ratios vary for different altitudes and flows. The regulator must meet the percentage requirements listed in the applicable table in the manual for the regulator being tested. Completing the worksheet and performing the oxygen ratio test are accomplished as described in detail for the 2858 regulator.

CAUSES AND REMEDIES FOR HIGH AIR AT 5,000, 10,000, AND 15,000 FEET ARE:

Cause: Weak check valve spring.

Remedy: Turn the adjusting screw in the air check valve retainer clockwise.

CAUSES AND REMEDIES FOR LOW AIR AT 5,000, 10,000, AND 15,000 FEET ARE:

Cause: Strong check valve spring.

Remedy: Turn the adjusting screw in the air check valve retainer counterclockwise.

Cause: Leaky injector.

Remedy: Tighten the mixing tube, seating the injector tighter on the gasket. Replace the injector gasket or seat as necessary.

Cause: The injector housing is not positioned correctly.

Remedy: Reposition the injector housing. The slot in the housing should be aligned with the slot in the air valve chamber.

CAUSES AND REMEDIES FOR HIGH AIR AT 20,000 FEET ARE:

Cause: Excessive throttling plate movement. The distance between the throttling plate and the aneroid housing seat too great.

Remedy: Replace with a longer shouldering screw. Unscrew shouldering screw and place a drop of glyptal on the threads.

CAUSES AND REMEDIES FOR HIGH AIR AT 25,000 AND 28,000 FEET ARE:

Cause: Excessive aneroid movement.

Remedy: Readjust aneroid to close sooner.

PRESSURE BREATHING TEST.—The automatic pressure breathing mechanism must cause the regulator to deliver positive pressure in accordance with conditions listed in the appropriate table for the regulator being tested. The proper tables for the pressure breathing test for each individual regulator are listed in the *Handbook of Overhaul Instructions*, AN 03-50A-48.

The check must be performed at an ambient flow of 10 l.p.m.

1. With the regulator mounted in the test stand and the air valve positioned to NORMAL, apply 150 p.s.i. pressure to the inlet of the regulator.

The test can be completed easier if there is an initial setting of the pressure breathing back. Screw in the pressure breathing back until a slight indication of pressure is noted on the pressure-suction manometer. Unscrew the pressure breathing back two full turns. Do not lock the strap as further adjustment will probably be necessary.

2. Using the outlet valve, ascend to altitude. All the altitudes required for this test are above the altitude at which the aneroid air valve closes. It will be necessary to ascend to higher altitudes by using the bypass valve.

3. Hold the altitude steady, set the indicated output flow, and record the pressure reading on the pressure-suction manometer of the test stand.

4. Ascend to succeeding altitudes specified, using the bypass valve. Record the pressure readings for each altitude.

5. Open the inlet valve and descend to sea level. Close valves, release the pressure, and secure the test.

It is advisable to ascend to the 43,000 foot altitude level for the first adjustment. Set the pressure breathing back mechanism to deliver between the minimum and maximum positive pressure in inches of water at this altitude and the majority of the altitudes will fall within the limits specified. Be sure the safety pressure knob is turned to the OFF position.

If the positive pressure is below the required minimum, turn the pressure breathing mechanism clockwise into the housing assembly; turn it counterclockwise if the pressure is beyond the specified maximum limits. If adjustment of the aneroid does not allow the proper calibration, it may be necessary to adjust the ratio lever (long bar). Set the clamp farther out toward the end of the slot in the lever to give lower outlet pressures at high altitudes and higher pressures at low altitudes. Set the clamp closer to the center of the lever to obtain opposite results.

At completion of the adjustment procedure, lock the aneroid cover in place by means of the strap.

SAFETY PRESSURE TEST.—The purpose of the safety pressure test is to determine the amount of positive pressure being delivered by the safety pressure. The safety pressure is manually operated. The purpose of the safety pressure is to prevent inboard mask leakage.

1. With the regulator mounted in the test stand, set the air valve at the 100 PERCENT position.

2. Apply 150 p.s.i. pressure to the inlet of the regulator. Set an indicated 10 l.p.m. flow on the output flowmeter.

3. Rotate safety pressure to ON. The pressure being delivered by the safety pressure will be indicated on the pressure-suction manometer. The safety pressure delivered must be 1.75 ± 0.25 inches of water. If there is a mechanical noise or vibration during this procedure, repeat the test.

4. Increase the output flow to an indicated 50 l.p.m., and record the pressure drop. The pressure drop must not be more than 1.0 inch of water.

CAUSES AND REMEDIES FOR HIGH SAFETY PRESSURE READINGS ARE:

Cause: Excessive spring tension.

Remedy: Decrease the pressure on the spring. Using two wrenches, loosen the stop nut and adjust the spring nut to the desired pressure reading. This operation can be performed while the regulator is in the test stand with the flow passing through the outlet.

CAUSES AND REMEDIES FOR LOW SAFETY PRESSURE READINGS ARE:

Cause: Insufficient spring tension.

Remedy: Increase the pressure on the spring by adjusting the spring nut to the desired pressure reading.

Excessive pressure drop with a 50 l.p.m. flow would be caused by a weak spring. A weak spring must be replaced with a stronger one. After the desired safety pressure has been attained, tighten the locknut. This will insure a constant spring tension, thereby delivering the proper amount of safety pressure to the user.

AUTOMATIC PRESSURE OXYGEN BREATHING REGULATOR

Description

The F1732 (Firewel) miniature oxygen breathing regulator is personnel mounted and is used both in the inflight and bail out or emergency conditions. The regulator is so designed that with an inlet pressure of 40 to 90 p.s.i., it will deliver 100 percent oxygen automatically to the user between the altitudes of 0 to 50,000 feet. In addition, the regulator incorporates automatic safety pressure buildup to a maximum of 2 inches of water below 35,000 feet and automatic pressure breathing for altitudes above 35,000 feet. It is designed to integrate with the A13-A oxygen breathing mask. The regulator assembly weighs 4 ounces and is approximately 3 inches in length and 2-1/2 inches in width.

The F1732 (Firewel) miniature regulator consists of a demand valve assembly, demand diaphragm safety pressure spring, pressure breathing aneroid, oxygen inlet bleed orifice, aneroid vent outlet, aneroid chamber, and relief valve. (See fig. 7-19.)

SAFETY PRESSURE.—An unbalance of the pressures on either side of the demand diaphragm will cause movement of the diaphragm in the direction of the lowest pressure. The force of the safety pressure spring (maximum of 2 inches of water pressure) causes motion of the demand diaphragm in the direction of the demand chamber. Motion in this direction causes actuation of the demand valve, thereby admitting oxygen from the 40 to 90 p.s.i. source to the regulator outlet and consequently to the A13-A oxygen mask. When the force on the demand chamber side of the diaphragm, due to the mask pressure, is equal to the force on the aneroid chamber side of the diaphragm, due to the safety pressure spring, the diaphragm becomes balanced and the demand valve closes. By this action a safety pressure of a maximum of 2 inches of water is maintained in the oxygen mask.

INHALATION.—The decrease in pressure in the demand chamber, due to inhalation, causes a motion of the demand diaphragm in the direction of the demand chamber. This will actuate the demand valve, allowing the oxygen required for inhalation to pass into the A13-A oxygen mask.

EXHALATION.—The increase in pressure in the demand chamber, due to exhalation, causes a motion of the demand diaphragm in the direction of the aneroid chamber. This motion allows the demand valve to close so that exhalation can be accomplished through the pressure compensated exhalation valve of the A13-A mask.

PRESSURE BREATHING.—The aneroid or pressure breathing control chamber consists of an aneroid preset to begin expanding at approximately 35,000 feet. Oxygen is continually transmitted from the 40 to 90 p.s.i. oxygen source through the oxygen inlet bleed orifice to the aneroid chamber and finally exhausted to the ambient through the aneroid vent outlet. Since the oxygen flow through the bleed orifice is minute (approximately 150 cc. per minute) and since this oxygen is continually exhausted to the ambient atmosphere, the aneroid chamber remains at essentially ambient pressures. However, as pressure breathing

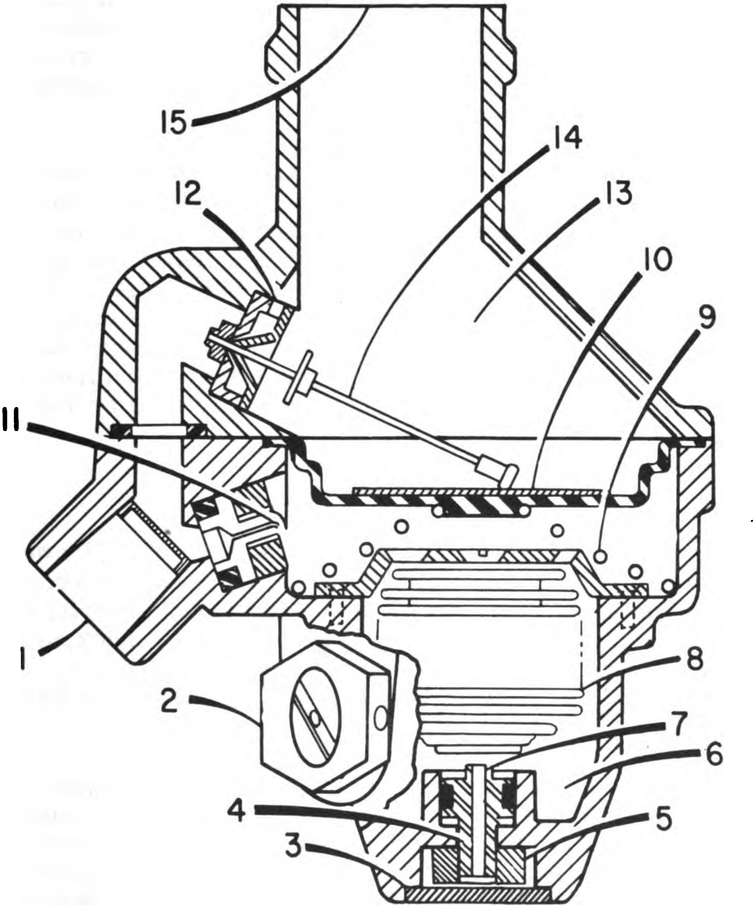


Figure 7-19.—Cutaway view of automatic pressure breathing regulator Part No. F1732 (Firewel).

1. Oxygen inlet.
2. Aneroid chamber relief valve.
3. Protective screen.
4. Aneroid adjusting screw.
5. Locknut of aneroid adjusting screw.
6. Aneroid chamber.
7. Aneroid vent hole.
8. Aneroid.
9. Safety pressure spring.
10. Demand diaphragm.
11. Oxygen inlet bleed orifice.
12. Injector slot.
13. Demand chamber.
14. Demand valve stem.
15. Regulator outlet.

altitudes are approached, the aneroid expands and gradually closes the aneroid vent outlet. This will increase the pressure maintained in the aneroid chamber, consequently backloading the aneroid side of the demand diaphragm with the same pressure.

The unbalance of the diaphragm causes motion of the diaphragm in the direction of the demand chamber, thereby actuating the demand valve and allowing oxygen to flow into the oxygen mask. When the force on the demand chamber side of the diaphragm, due to the mask pressure, is equal to the force on the aneroid side of the diaphragm, due to the aneroid chamber pressure, the diaphragm becomes balanced and the demand valve closes. By this action the pressures are maintained in the oxygen mask for the altitudes shown in table 7-3 at ambient flows of 10 l.p.m.

Disassembly

While disassembling the 1732 and F1732 (Firewel) regulators, it is important that all parts be kept in a clean and dust-free area. Refer to the exploded view, figure 7-20, and disassemble in the order of the key index numbers, using the following special tools as necessary:

F2513 Ring hook (to remove the filter from regulator inlet).

F2515 Punch (to secure filter to regulator inlet).

F2516 Wrench (to secure orifice locknut to body).

F2514 Screwdriver (used in conjunction with wrench above to adjust the adjustable aneroid valve and its locknut).

DEMAND CHAMBER.—Disassemble the regulator by removing the four housing screws that hold the demand chamber and aneroid pressure chamber together. Lay aside the aneroid pressure chamber after removing the spring and diaphragm. Examine the demand diaphragm for tears, nicks, holes, and distortion. Examine the demand valve housing with particular attention to the positioning of the demand valve assembly. Remove the two demand valve holddown screws. Remove the demand valve assembly by applying oxygen pressure to the regulator inlet. NEVER PULL ON VALVE STEM TO REMOVE VALVE. Remove the demand valve gasket located in the demand valve well and examine for abuse.

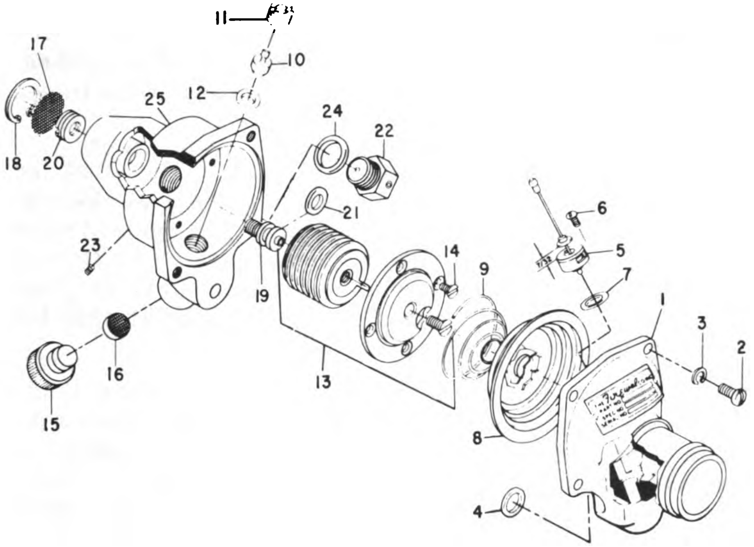


Figure 7-20.—Exploded view of miniature automatic pressure breathing regulator.

1. Body.
2. Screw.
3. Washer.
4. O-ring.
5. Demand valve assembly.
6. Screw.
7. Gasket.
8. Diaphragm assembly.
9. Spring.
10. Orifice assembly.
11. Locknut.
12. O-ring.
13. Aneroid and mounting plate assembly.
14. Screw.
15. Plug, 1/8-inch pipe dust.
16. Filter.
17. Screen.
18. Ring.
19. Valve, adjustable aneroid.
20. Locknut.
21. O-ring.
22. Valve assembly, pop-off.
23. Screw.
24. O-ring.
25. Cover.

ANEROID PRESSURE CHAMBER.—Remove the four aneroid cover screws. Turn the aneroid housing over and the aneroid and top cover will come out. DO NOT SHOCK ANEROID OR THE ANEROID WILL BECOME SPRUNG.

Disassembly Inspection

Inspect the mating surfaces of the body (1) and cover (25). They must be free of nicks, burrs, and scratches. Inspect all threaded areas of the body and cover to see that they are clean and serviceable.

Inspect the demand valve seat (5) to see that the silicone compound is securely bonded to the seat. Inspect silicone surface for cuts or abrasions. The demand valve guide (pressure-fitted into the demand valve seat) must be properly seated. The vent of the demand valve guide must be 180 degrees opposite the rectangular injector port of the demand valve seat.

Inspect to see that the tip and deflector plate are firmly in place on the stem. Check the dimensions between the face of the deflector plate and the face of the guide, as shown in figure 7-19. This dimension must be 7/32 inch. Check the demand valve stem for straightness, and check to see that it tilts freely. All areas of the demand valve assembly must be free of nicks, scratches, and abrasions. If any of the above conditions are not fulfilled, replace the demand valve assembly.

Inspect the seat of the adjustable aneroid valve (19). It must be smooth and free of nicks and scratches, and the threads must be clean and serviceable.

Carefully inspect the aneroid assembly (13). With the aneroid mounting plate removed, check the length of the aneroid (do not include the silicone valve seat). This dimension must be 0.616 ±0.010 inch. Inspect the aneroid bellows for dents or scratches. Check the aneroid to see that the silicone seat is free of nicks and abrasions, and that the seat is securely bonded to the aneroid. Check the mating surfaces of the aneroid and aneroid mounting plate. They must be free of nicks, burrs, and scratches. If any of these conditions are not fulfilled, replace the aneroid assembly.

Inspect the spring (9) to see that the coils are not distorted. Inspect the popoff valve assembly (22). It must be free of nicks, burrs, and scratches, and the threads must be clean and serviceable.

Cleaning

Clean all metal parts, using filtered benzene, Navy Specification No. 51-B-3, and dry with a blast of clean, dry, oil-free air.

At the 250-hour overhaul, clean the diaphragm assembly (8) with a lightly dampened cloth, using acetone, Federal Specification MIL-T-7003. DO NOT IMMERSE THE DIAPHRAGM ASSEMBLY.

Replacement of Parts and Reassembly

REPLACEMENT OF PARTS.—At the 250-hour overhaul, the demand valve assembly (5) and filter (16) are replaced. At the 500-hour overhaul, the diaphragm (8), orifice (10), filter (16), and demand valve assembly (5) are replaced. (See fig. 7-20.) Replace all parts that do not meet inspection standards. Also replace those parts as determined by test procedures. No lubrication is necessary on any part of this regulator.

REASSEMBLY.—Reassembly of the 1732 and F1732 regulator is essentially the reverse of disassembly, with the following exceptions:

Carefully assemble the demand valve assembly (5) to the body (1), and adjust it so that the rectangular injector port in the seat of the demand valve assembly is exposed to one-third the width of the slot in the body.

After attaching the demand valve assembly to the body, check to see that the vent in the guide of the demand valve assembly has not shifted. This vent must be 180 degrees opposite the rectangular slot in the seat of the demand valve assembly.

To assemble the orifice (10) to the cover (25) with locknut (11), refer to the special tools listed and use applicable tool. The spring (9) must be properly seated when assembled to the cover. After assembly, gently depress the spring within the cover and check to see that the spring action is not impeded in any way. Check in particular the area of the orifice for any obstruction to spring action. If spring action is impeded, reseat the spring within the cover to ideal position.

Referring to figure 7-21, reassemble the cover and spring to the body and diaphragm by engaging the top conical of the spring with the silicone centering disc of

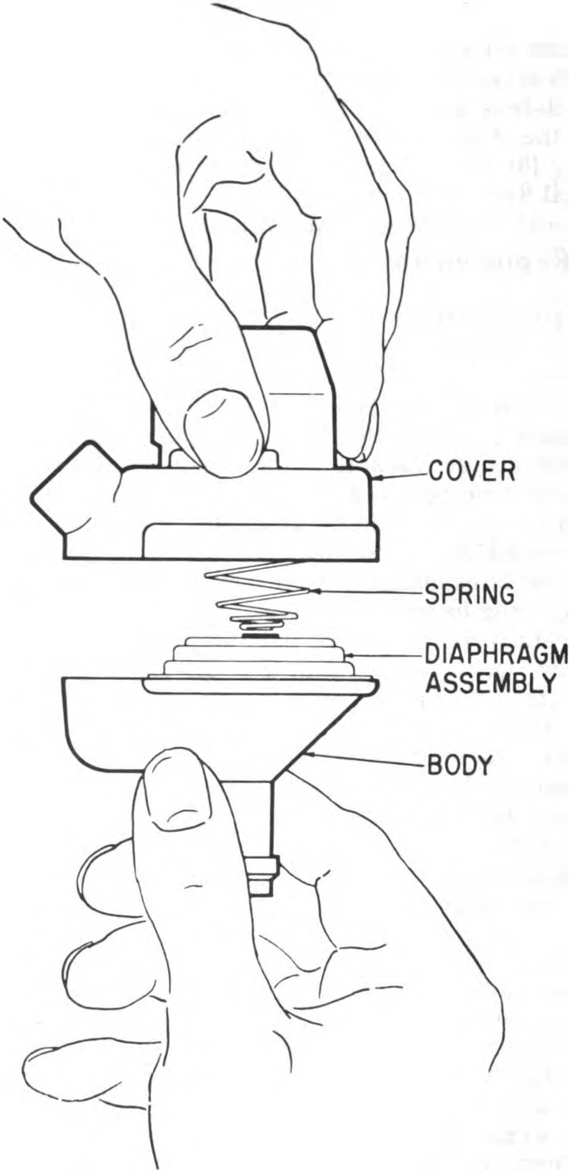


Figure 7-21.—Reassembly procedure for cover, spring, diaphragm, and body.

the diaphragm assembly, and carefully align the cover to the body. Before securing the cover to the body, be absolutely certain that the diaphragm is properly seated in the diaphragm counterbore of the cover. A careful examination of the mating surfaces of the cover and body, as they are hand held in the assembled position, will indicate proper or improper alignment of these parts. Do not secure cover to body until it is determined that the proper alignment is obtained.

To assemble the new filter (16) to the cover, refer to the special tools listed and use the applicable tool for spreading the ring of the filter to secure it to the cover. The screen (17) and snap ring (18) are not assembled to the cover until after the test procedures are performed.

TEST PROCEDURE

Ground Level Difficulties

The test procedures are set up in accordance with figure 7-22. Each individual test setup is given for each malfunction.

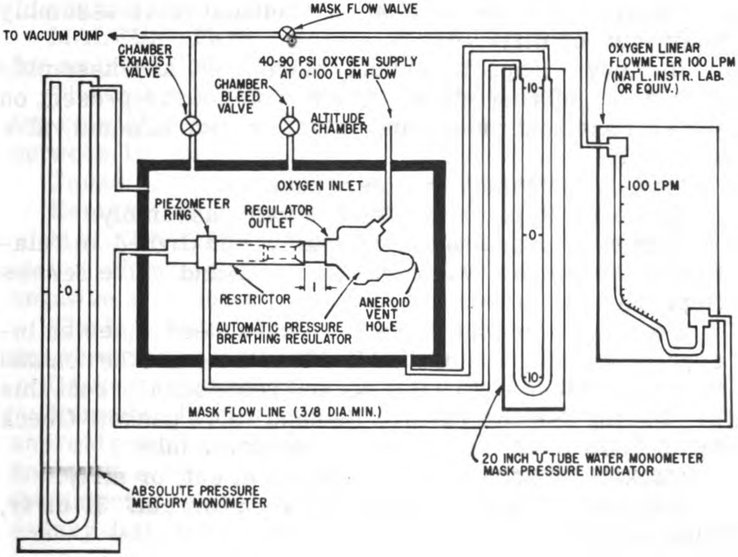

MASK FLOW VALVE
TO VACUUM PUMP
CHAMBER EXHAUST VALVE
40-90 PSI OXYGEN SUPPLY AT 0-100 LPM FLOW
CHAMBER BLEED VALVE
ALTITUDE CHAMBER
OXYGEN LINEAR FLOWMETER 100 LPM (NAT'L. INSTR. LAB. OR EQUIV.)
10
100 LPM
OXYGEN INLET
PIEZOMETER RING
REGULATOR OUTLET
0
0
RESTRICTOR
ANEROID VENT HOLE
AUTOMATIC PRESSURE BREATHING REGULATOR
10
MASK FLOW LINE (3/8 DIA. MIN.)
20 INCH "U" TUBE WATER MONOMETER MASK PRESSURE INDICATOR
ABSOLUTE PRESSURE MERCURY MONOMETER

Figure 7-22.—Schematic test diagram.

MALFUNCTION.—Mask pressure continually builds up at altitudes below 35,000 feet.

The test setup is with regulator outlet flow valve shut off.

Table 7-3.—Specified altitudes and the minimum and maximum mask pressure in inches of water.

Pressure altitude in feet	Mask pressure inches of water	
	Minimum	Maximum
35,000		3.5
37,000		5.7
39,000		8.0
40,200	2.0	9.4
41,000	4.0	10.2
41,500	6.0	10.8
42,500	8.0	12.0
43,000	10.0	12.5
50,000		18.0

Cause: Silicone seat on the demand valve assembly worn, cut, or dirty.

Remedy: Inspect demand valve seat and assembly with a magnifying glass. If any defects are present on the silicone seat or demand valve, replace demand valve assembly.

Cause: Demand valve stem bent.

Remedy: Replace the demand valve assembly.

Cause: Demand valve assembly misaligned in relation to the demand valve gasket. Demand valve screws improperly tightened.

Remedy: Demand valve may have been inserted incorrectly during assembly. If this is the case, the demand valve assembly will be in a cocked position. Correct this by aligning demand valve on demand valve gasket. Check by applying oxygen pressure to regulator inlet.

Cause: Demand valve gasket worn, cut, or dirty.

Remedy: Replace gasket if worn or cut. If dirty, wipe clean.

Cause: Sprung aneroid. This causes the aneroid vent hole to be closed and pressure to build up behind the demand diaphragm. The mask pressure will build up and hold at approximately 18 inches of water due to action of the preset relief valve.

Remedy: Remove the aneroid from the housing. Hold the aneroid between the thumb (on aneroid cover) and index finger (on silicone seat) and squeeze. If the aneroid depresses from this pressure, the aneroid is sprung and must be replaced.

Cause: Hole in diaphragm. This allows gas to escape through the diaphragm. The spring force then holds the diaphragm against the demand valve, keeping it in the open position.

Remedy: Replace the diaphragm.

MALFUNCTION.—Regulator delivers more than the required 2 inches of water, and holds static above 2 inches of water.

Test setup is with regulator outlet flow valve shut off.

Cause: Safety pressure spring too strong.

Remedy: Replace the spring.

Cause: Oxygen inlet bleed is in excess of 150 cc per minute flow, causing an increase of pressure on back of the demand diaphragm.

Remedy: Replace the oxygen bleed orifice.

MALFUNCTION.—Regulator outlet pressure negative for ambient flows less than 30 l.p.m.

The test setup is in accordance with figure 7-22, with the regulator outlet flow valve set at various flow rates between 10 and 30 l.p.m.

Cause: Safety pressure spring too weak.

Remedy: Replace the spring.

MALFUNCTION.—Regulator operates satisfactorily at low flows, but the regulator outlet pressures are negative at ambient flows less than 100 l.p.m.

The test setup is with the regulator outlet flow valve set at various flow rates up to 100 l.p.m.

Cause: Demand valve injector slot closed too much.

Remedy: Disassemble the demand chamber from the aneroid pressure chamber. Loosen the two demand valve holddown screws and maneuver the demand valve so that the injector slot is from 1/2 to 3/4 open or, if necessary fully open. Retighten holddown screws and retest. Be careful to correctly align the demand valve and gasket.

MALFUNCTION.—Regulator relief valve does not relieve when mask pressure is in excess of 18 inches of water.

Test setup is in accordance with figure 7-22, with the regulator outlet flow valve shut off and aneroid vent hole blocked off with finger.

Cause: Setting of relief valve too high.

Remedy: Back off the relief valve adjusting screw until the relief valve opens between 8 to 17 inches of water at sea level. Best optimum setting is between 11 and 12 inches of water. Then test at 50,000 foot altitude noting if the relief valve opens at 16 ± 2 inches of water. Drop altitude to determine that the relief valve closes at 11 inches of water.

MALFUNCTION.—Regulator relief valve relieves before the desired range of 16 ± 2 inches of water at altitude and 8 to 17 inches of water at sea level.

Test setup is with the regulator outlet flow valve shut off, and the aneroid vent hole blocked off with finger.

Cause: Relief valve adjusting screw improperly set.

Remedy: Loosen Allen screw on the relief valve body and tighten the relief valve adjusting nut in clockwise direction.

Cause: Leak at relief valve O-ring where the relief valve body is joined to the regulator body.

Remedy: Tighten valve into the body, or replace the O-ring.

Cause: Leak at joint of demand valve body and aneroid housing around the diaphragm.

Remedy: Tighten the 4 housing screws, being sure that the diaphragm did not fold on the initial assembly.

Cause: Hole in the diaphragm.

Remedy: Replace the diaphragm.

Cause: Oxygen inlet bleed orifice plugged.

Remedy: Replace the oxygen bleed orifice.

Cause: Excessive low-pressure supply.

Remedy: Bring test stand inlet supply pressure to 40-90 p.s.i. Also examine the inlet screen for dirt or other matter which may block inlet pressure flow.

NOTE: If none of the remedies are applicable, replace the relief valve in its entirety.

MALFUNCTION.—Pressure breathing cuts in below 35,000 feet or mask pressure builds up in excess to pressures listed in table 7-3.

Test setup is in accordance with figure 7-22, at altitudes above 35,000 feet. Regulator outlet flow set for 10 l.p.m. ambient flow.

Cause: Aneroid adjusting screw down too far in the body.

Remedy: Back off aneroid adjusting screw locknut. Back off aneroid adjusting screw until desired range is reached.

Cause: Seat end of aneroid adjusting screw too long.

Remedy: Remove aneroid adjusting screw and grind down the seat with emery cloth.

Cause: Aneroid silicone seat may be too thick.

Remedy: Remove and replace silicone seat.

Cause: Aneroid sprung.

Remedy: Sprung aneroid is evident if it is possible to compress it by hand. If this is the case, replace the aneroid and properly adjust the new one to the desired altitude range.

MALFUNCTION.—Pressure breathing cuts in above 29,000 feet or mask pressures are less than those listed in table 7-3.

Test setup is in accordance with figure 7-22, at altitudes above 39,000 feet. Regulator outlet flow valve set at 10 l.p.m. ambient flow.

Cause: Aneroid adjusting screw too far out of the body.

Remedy: Loosen aneroid adjusting screw locknut. Tighten the aneroid adjusting screw until desired closing range is noted.

Cause: Aneroid silicone seat may be worn, cut, or dirty.

Remedy: If silicone seat shows any evidence of being worn or cut, replace. If dirty, clean with recommended specified cleaner. It is possible that a minute particle of dirt may penetrate through the aneroid adjusting screw vent hole and lodge between the aneroid adjusting screw seat end and silicone seat, preventing the aneroid from closing properly.

Cause: Case may be leaking.

Remedy: Examine at ground level by applying soapy water solution to mating joint of demand valve chamber and aneroid chamber. With pressure applied to the regulator inlet, hold finger over the aneroid vent hole and relief valve.

Cause: Oxygen inlet bleed orifice stopped or retarded.

Remedy: Replace the bleed orifice.

Cause: The relief valve leaking below pop-off pressure.

Remedy: Readjust the pop-off valve and, if this does not work, replace the relief valve in entirety.

Cause: Diaphragm has a minute hole in it.

Remedy: Replace the diaphragm.

Cause: Excessively low test stand inlet pressure.

Remedy: Increase the test stand inlet pressure to 40-90 p.s.i.

Attaching the 1732 Regulator to the A13-A Oxygen Breathing Mask

The miniature regulator 1732 (Firewel) is designed to be integrated with the A13-A oxygen breathing mask, as shown in figure 7-23. The procedure for integrating the regulator, breathing tube, and communication cables are as follows:

Replace the existing A13-A mask breathing tube with the miniature breathing regulator by inserting the outlet of the regulator into the mask inlet port. Clamp the regulator to the mask with a hose clamp.

Connect the oxygen hose to the oxygen inlet supply port of the regulator. The oxygen hose contains four wire conductors fabricated into the wall of the hose, which emerge from the regulator end of the hose as two cables. The cable containing the red and green conductors is attached directly to the mask microphone. (See fig. 7-23.) The cable containing the black and white conductors is attached to a female jack which, in turn, is connected to the existing headset plug.

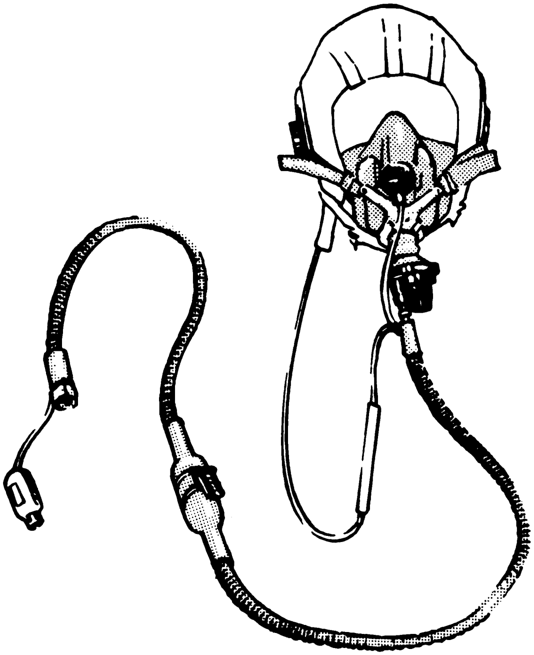


Figure 7-23.–Firewel miniature oxygen breathing regulator, 100 percent type, with automatic safety pressure and automatic pressure breathing.

QUIZ

1. If the hole in the pressure reducer liner was not lined up properly with the hole in the pressure reducer chamber, the result would be
    a. high inlet pressure
    b. a restricted flow to the demand valve
    c. excessive flow to the demand valve
    d. low inlet pressure

2. If a 2867 regulator is reassembled without installing the counterweight, the
    a. regulator will fail to deliver oxygen
    b. demand valve will not function properly
    c. regulator will function normally, unless the aircraft is engaged in violent maneuvers
    d. regulator will not function, because there is no place to hook up the diaphragm

3. When checking the flow indicator for leakage on the 2873A1-B regulator,
    a. connect the regulator to a high pressure source, actuate the safety press, and soap the outlet
    b. actuate the safety press and soap the blinker tube
    c. apply 10 inches pressure and soap the vent and breather tube
    d. connect the regulator to a high-pressure source, actuate safety pressure, and soap the vent and blinker tubing
4. The primary purpose of safety pressure is to deliver a
    a. continuous flow of oxygen
    b. flow of undiluted oxygen from the regulator
    c. flow of undiluted oxygen under pressure at low altitudes
    d. flow under added pressure to prevent inboard mask leakage
5. When the safety pressure is properly adjusted, it will deliver______inches of water at the outlet.
    a. 17.5 ± 2.5
    b. 1.75 ± 0.25
    c. 12.5 ± 0.75
    d. 1.25 ± 0.75
6. When adjusting the pressure reducer assembly, install a pressure gage in the
    a. lower demand valve chamber, and set pressure at 55-65 p.s.i.
    b. upper demand valve chamber, and set pressure at 55-65 p.s.i.
    c. pressure reducer assembly, and set pressure at 55-65 p.s.i.
    d. opening on inlet valve assembly, and set pressure at 55-65 p.s.i.
7. If, when conducting a pressure breathing back test at 43,000 feet, the altitude is noticed dropping, a leak is probably in the
    a. test stand
    b. regulator outlet gasket
    c. input flowmeter
    d. blinker tubing
8. When the safety pressure is actuated, the
    a. long lever pivots the short lever, which depresses the diaphragm
    b. short lever pivots the counterweight, which depresses the diaphragm
    c. short lever pivots the long lever, which depresses the diaphragm
    d. counterweight lever depresses the diaphragm

9. The ratio, by volume of cylinder oxygen delivered, to the total gas delivered by the regulator
    a. is not affected by altitude, if the air valve is at "normal"
    b. will vary with the altitude, if air valve is on "normal"
    c. will be affected by altitude if air valve is on "100 percent"
10. The injector assembly is designed to increase the flow
    a. automatically with increasing altitude
    b. when subjected to a heavy suction
    c. when safety press is used
    d. when the pressure breathing mechanism delivers 4 or more inches of water pressure
11. The composite regulator which will cause no altitude drop at 40,000 feet, due to a ruptured piston seal, is the
    a. 2873-B1
    b. 2867-A1B
    c. 2862-A2
    d. 2872-A1B
12. The test that is not performed on 2867 regulators is the
    a. flow suction test
    b. safety pressure test
    c. oxygen ratio test
    d. emergency flow test
13. When performing the overall leak test on a 2867 regulator, the maximum allowable pressure drop is
    a. 200 p.s.i. in 1 minute
    b. 100 p.s.i. in 2 minutes
    c. 200 p.s.i. in 2 minutes
    d. 100 p.s.i. in 5 minutes
14. If, in performing an oxygen ratio test on a 2867 regulator, the input flowmeter reads low according to the performance chart,
    a. the demand valve is sticking
    b. the aneroid is closing too late
    c. too much cylinder oxygen is being supplied
    d. too little cylinder oxygen is being suppiied
15. At 40,000 feet, a 2863 regulator should deliver a positive pressure of approximately______inches of water.
    a. 1.75
    b. 6.00
    c. 8.00
    d. 10.0

16. To obtain the corrected indicated output for an oxygen ratio performance sheet, read the output graph from
   a. left to altitude line, then down
   b. bottom to altitude line, then down
   c. bottom to altitude line then left, and correct for added oxygen
   d. left to altitude line, then down, and correct for added oxygen
17. The maximum allowable pressure drop in the safety pressure test is_____ inch at_____l.p.m. output.
   a. 1; 10
   b. 1.75; 50
   c. 1; 50
   d. 0.5; 10
18. The A-1 type inlet valve is torqued to
   a. 300 inch-pounds
   b. 30 inch-pounds
   c. 300 foot-pounds
   d. 30 foot-pounds
19. When testing a composite regulator for safety pressure, the outlet valve is opened to
   a. take away the initial pressure when the safety press is actuated
   b. test the safety pressure under a specified flow
   c. keep the pressure from blowing the oil
   d. raise the stand to test altitude
20. A subassembly that is part of the 2863 regulator, but NOT part of the 2867 is the
   a. pressure breathing back
   b. safety press (push-pull type)
   c. supply shutoff valve
   d. safety press (rotary type)
21. All composite diluter demand regulators shall be removed from the aircraft and shop tested when
   a. they fail to pass the ground-crew check
   b. they have been in service 90 days since the last shop test
   c. the aircraft in which they are installed is undergoing a major overhaul
   d. all of the above apply
22. The demand valve lever on the 2867 regulator is set to
   a. 33/64 inch below the edge of the case with 150 p.s.i. inlet pressure
   b. 11/64 inch above the edge of the case with 100 p.s.i. inlet pressure
   c. 33/64 inch below the edge of the case with 100 p.s.i. inlet pressure
   d. 11/64 above the edge of the case with 150 p.s.i. inlet pressure.

23. High suction on a 2867 regulator could be caused by the
    a. demand valve lever set too high
    b. pressure reducer set too high
    c. leaky inlet valve
    d. weak injector spring

24. If, when the demand valve is depressed, the regulator emits a howl, the
    a. injector spring may be weak
    b. injector spring may be too strong
    c. injector damping spring is defective
    d. pressure reducer liner is defective

25. With correct low air at 20,000 feet, replace the
    a. shouldering screw with a longer one
    b. check valve spring with a weaker one
    c. shouldering screw with a shorter one
    d. check valve spring with a stronger one

CHAPTER 8

MAINTENANCE OF CO_2 TRANSFER EQUIPMENT

CO_2 transfer units are supplied to the Navy by the C-O-Two Fire Equipment Company of Newark, New Jersey, and the Walter Kidde Company of Belleville, New Jersey. Both of these units and their related equipment are discussed in this chapter.

C-O-TWO TRANSFER UNIT

The transfer unit shown in figure 8-1 is furnished with the motor, stand, hose, and adapters. The cylinder stand and cylinder are not a part of the unit and must be provided locally. The motor-driven pump is designed with one cylinder, operating as a single-acting reciprocating type. It is manufactured from corrosion-resistant metal, and is mounted on a base support. Mounted on a sliding base, the motor can be adjusted to maintain the proper tension on the drive belt. The working pressure of the pump is approximately 3,500 p.s.i. and the unit is capable of transferring 80 percent or about 38 pounds of carbon dioxide from a fully charged 50-pound supply cylinder.

The pump head is fitted with a frangible safety disc designed to relieve pressure in the pump between 2,700 p.s.i. to 2,900 p.s.i. When the disc ruptures, a safety disc nut prevents any recoiling action. Ruptured discs are replaced easily.

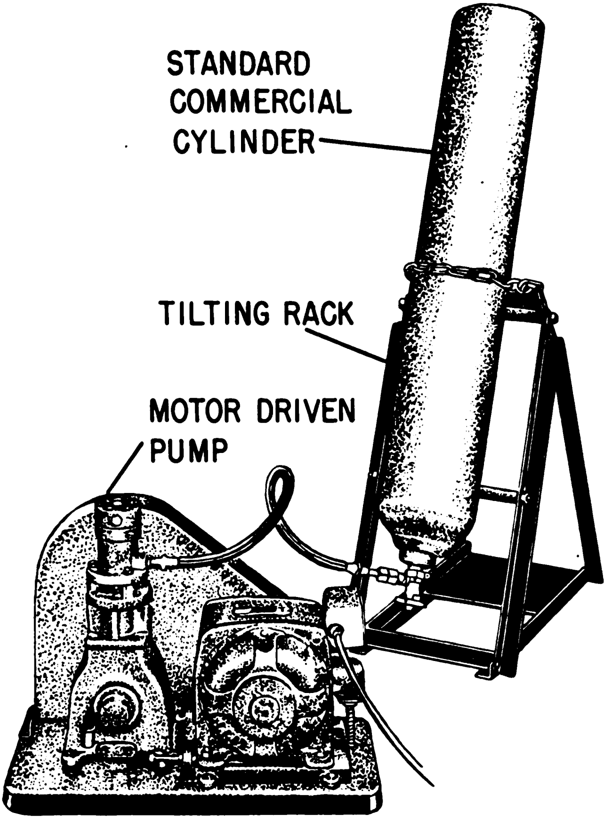


Figure 8-1.—C-O-TWO transfer unit.

The lower half or crankcase end of the pump is ruggedly constructed. The crankcase proper is made of close-grained nickel iron which is fitted with a well-baffled breather, oil filter, and drain plug. A positive oil seal is provided at the crankshaft. The crankshaft (center crank, counterbalanced construction) is made in one piece of drop-forged, heat-treated steel. At each end of the crankshaft is an extra large tapered adjustable roller bearing (single-row, antifriction type).

The connecting rod (shaped in the conventional I-section of automotive design) is also made of drop-forged, heat-treated steel. A shim-adjusted babbitted bearing is provided at the crankpin. The wristpin in the crosshead is of hardened polished steel and is furnished with a graphite bronze bushing, fitted with an oil groove. The crosshead, made of wear-resistant material, is also fitted with an oil groove.

The lubricating system is the automatic-controlled splash type, while the oil flow is regulated by a fixed orifice in the oil trough.

Packing is provided at the entrance of the piston rod into the cylinder which is especially designed for tightness at high working pressures and for ease of adjustment.

The drive from the motor to the pump is a combination of V-belt drive pulleys and gears. The small gear and large pulley are assembled together as a unit, and are both fitted with ball bearings and mounted on the idler shaft. Both pulleys are carefully balanced. A single guard is secured over both gears and pulleys.

The motor furnished as standard equipment is a 1-horsepower capacitor start induction type. It is suitable for operation on either a 110- or 220-volt, single-phase, 60-cycle circuit. (A d-c motor is also available.) An enclosed control switch is located accessibly on the side of the motor.

ERECTION AND OPERATION NOTES.—After receiving the equipment, examine components for damage. If the unit is damaged (under ordinary circumstances), do not attempt repairs. Return it to the supply officer who will direct its reshipment to the manufacturer.

Since the oil has been drained from the crankcase of the pump for shipment to field activities, make certain it is filled with a standard grade of S.A.E. No. 30 lubricating oil before starting the unit. On pumps equipped with an oil filter plug and measuring stick, fill only to the upper groove on the stick. On a unit equipped with an oil cup on its side, having no measuring stick, fill to within 1/4 inch of the top of the cup. Other than the crankcase, there is only one other point on the pump that requires lubrication. This is on the shaft of the idler gear and pulley and is equipped with an alemite lubrication fitting. In spite of the fact that the pulley shaft has been prelubricated at the factory, it is advisable to relubricate the area with 2 or 3 applications (grease gun shots) of light cup grease before starting. The motor bearings contain enough grease to last for approximately 2 years, under average conditions.

Before running the pump, an electric circuit compatible to the motor must be found or be installed in the shop. Unless otherwise specified, motors are wired to operate on 110-volt, 60-cycle, single-phase circuits. When 220-volt, 60-cycle, single-phase current is available, the hookup of the motor should be rearranged so that it can be operated on this circuit. (A 220-volt wiring diagram is shown on the nameplate of the motor.) The plug on the end of the lead conducting the current to the motor from the power outlet should be equipped with a grounding wire (the third wire, usually containing a white covering). Regardless, whether a 3-pronged plug or a pigtail (coming out of the lead near a 2-prong plug, fitted with a clip) is used, the system to which this grounding wire is attached must also be grounded for the unit to be protected.

Always "run-in" a new pump (or one that has been idle for a long time). This action, accomplished with the CO_2 hoses disconnected, is performed as a check for lubrication to make certain that all parts are thoroughly treated. After turning off the pump, wipe off all excess lubricants.

Before pumping carbon dioxide, examine all live connections on both the inlet and outlet hoses. Make certain all connections between components are tight. This is important since carbon dioxide is stored under high pressure (approximately 850 p.s.i. at atmospheric temperature of 70° F.). Tighten connections with a wrench no larger than 12 inches, using a slow steady pull.

The transfer unit will pump carbon dioxide in its liquid phase only. This is true of all CO_2 transfer units. Since the amount of liquid carbon dioxide contained in a fully charged cylinder varies with the pressure and temperature (a standard 50-pound cylinder contains approximately 38 pounds of carbon dioxide in its liquid phase and 12 pounds in its gaseous phase at atmospheric temperature 70° F.), it follows that the cooler the supply cylinder and the cylinder being recharged, the more efficient the operating of the transfer unit will be. Consequently, all cylinders should be kept in the coolest location possible. For the same reason, the time required to charge an empty cylinder increases with the temperature of the cylinders.

After all the liquid carbon dioxide is transferred from the supply cylinder which is approximately 80 percent of the net contents, the efficient transfer of CO_2 to the cylinder being recharged will cease. After this, another fully charged supply cylinder must be used to finish charging the cylinder to its full rated capacity. The majority of gas in the other supply cylinder can be used when recharging another empty cylinder, as the gas will transfer itself under its own pressure until the pressure in both cylinders is equal. In this way, the most economical use of the contents of the supply cylinder is made.

To prevent expansion of carbon dioxide in the supply hose and consequently blocking the hose with CO_2 "snow," the valve should have an outlet opening of at least 1/8 inch in diameter, preferably 3/16 inch. Standard supply cylinders in 50-pound sizes are obtainable with or without a syphon tube. When ordering cylinders, specify the ones with a syphon tube. Those without syphons must be inverted during the transfer process.

Maintenance

ONCE EVERY MONTH.—Inspect the level of the oil in the crankcase and see that it is within the limits specified.

ONCE EVERY SIX MONTHS.—Lubricate the idler shaft with two or three applications of light cup grease; also, lubricate the gear teeth with a thin coating of the same grease. With a small brush, apply a light coating of vaseline to the piston rod. To do this, dip the brush in vaseline and hold the brush against the piston rod while rotating the gears manually until the piston rod has been coated completely. If necessary, tighten the packing at the piston stem. A special wrench is needed for this operation. Do not tighten excessively. Because of the design of the packing, it is necessary to make only a snug adjustment in order to have it hold tightly.

Keep the commutator of the motor clean. Under normal operating conditions, the commutator will require only occasional cleaning with a dry piece of nonlinting cloth. Never lubricate the commutator.

ONCE EVERY TWO YEARS.—Drain and refill the crankcase at least once every two years. The bearing housings of the motor which also need attention at this time should be cleaned and regreased by a qualified electrician.

TO REPLACE THE PISTON ROD PACKING.—The steps involved follow:

1. Remove the six bolts on top of the cylinder head. Remove the cylinder head.

2. Loosen hex nut (fig. 8-2) at the bottom of the piston rod.

3. Remove the three bolts which hold the cylinder body to the crosshead guide unit.

4. Raise the cylinder body and unscrew the piston rod from the crosshead so that it clears the base.

5. The piston rod packing is now in a position to be replaced. Remove the locknut from the piston rod, and then remove the piston rod packing nut.

6. When replacing the flanged-type packing, remember that the packing nut serves only to hold the packing in place. Tightening the nut excessively WILL NOT increase its efficiency; and the packing nut should not be forced down tight enough to damage the packing flange.

7. After replacing the packing and packing nut, mount the cylinder body on the crosshead guide, making certain that the locknut is replaced on the piston rod before screwing it into the crosshead.

8. Screw the piston rod into the crosshead until the top edge of the piston packing is flush with the top of the cylinder body, with the crosshead in the uppermost position. (See fig. 8-2.) Check this adjustment by rocking the crank back and forth before tightening the locknut at the bottom of the piston rod.

9. Replace the piston head and tighten all the mounting bolts.

WALTER KIDDE TRANSFER UNIT

The "Kidde" recharging pump, like the other one, has been designed and manufactured expressly for the purpose of transferring carbon dioxide in its liquid form from one cylinder to another. The pump is supplied complete with the necessary adapters, recharging valves, safety discs and bushings, nuts, bolts, and washers for making connections to the cylinders, and for minor adjustments to the unit. Pumps, models 4211 and 4211-1, are driven by

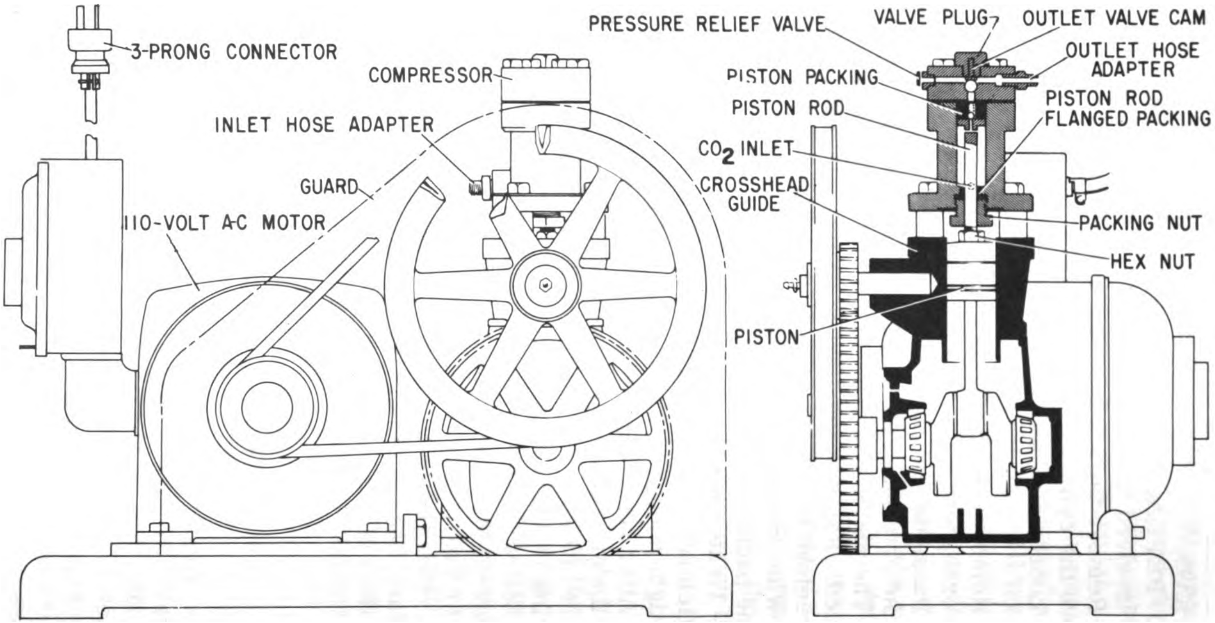


Figure 8-2.—Cross section of C-O-TWO transfer unit.

a 3/4-horsepower motor and are equipped with a safety switch and lead fitted with a plug. Three-prong plugs and three-wire leads should be substituted for the ordinary two-wire, and two-prong arrangement. Pump models 4306 and 4306-1 are driven by a single-cylinder, four-cycle, air-cooled engine of 3/4 horsepower. Figure 8-3 illustrates the W.K. electric recharge pump, model 4211-1.

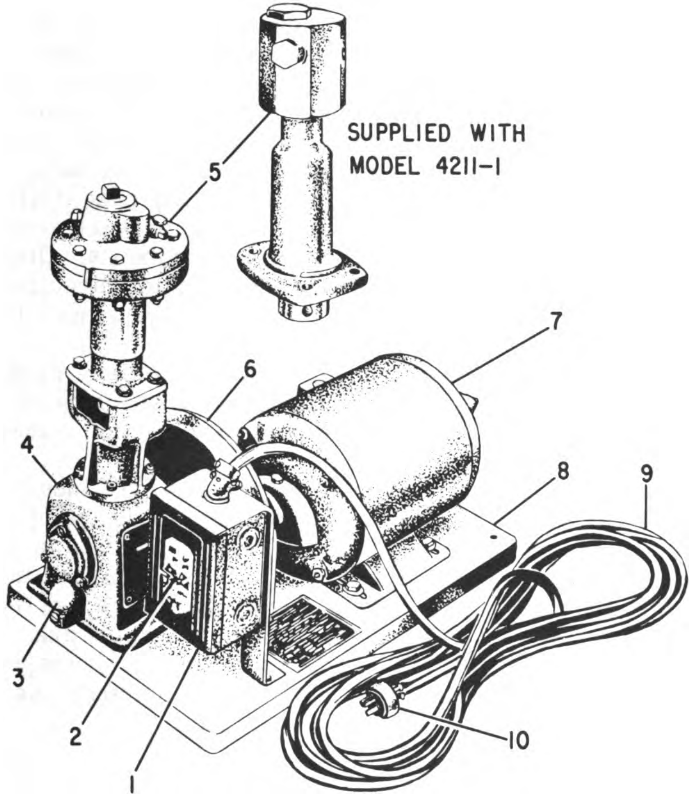


Figure 8-3.—Walter Kidde electric CO_2 transfer unit-model 4211.

1. Milti-breaker.
2. Power switch.
3. Oil filler cap.
4. Running gear assembly.
5. Compressor assembly.
6. Gear guard.
7. Motor.
8. Base.
9. Power cable.
10. Change to three-prong plug.

ERECTION AND OPERATIONAL NOTES.—Much of this information has been discussed for the C-O-TWO transfer unit and need not be repeated; however, where a difference has been noted, it will be discussed.

After uncrating and inspecting the unit, make certain that the crosshead clears the packing nut. To do this, turn the master gear attached to the crankshaft. The mechanism must work freely.

Fill the crankcase with a standard grade of S.A.E. 20 motor oil. *Caution:* DO NOT use any oil or grease in the cylinders or in any of the adapters of hose connections used to convey carbon dioxide. (Since this precaution was not specifically stated in the instructions for the adapters connected to the other pumping unit, this is not meant to imply that oil or grease can be used in the adapters of the C-O-TWO Company's equipment. In any case, follow the manufacturer's instructions, adding or subtracting nothing, contained in their respective handbooks. Obviously however, where Bureau of Aeronautics directives are concerned, the latter will take precedence over the manufacturer's instructions.)

Instead of a 12-inch wrench, W.K. instructions direct the use of one 10 inches long to tighten all hose-connecting joints. While tightening, care should be taken not to twist the hose.

A strainer and strainer adapter (fig. 8-4) are inserted into the inlet line (at the supply cylinder) to the pump to prevent any dirt or turnings which may accumulate in the supply cylinder from blowing over into the pump and imparing the action of the valves. Knowledge of the function of the strainer in relation to a possible trouble area is important to the technician when attempting to analyze the cause of malfunctioning pump valves or other associated parts.

Maintenance

LUBRICATION.—The instruction book for this equipment simply recommends inspecting the oil level in the crankcase periodically and changing it as necessary. Here, experience with pumps dictates the time of action. One can establish and maintain a schedule compatible with the experience gained through operating the equipment. The plunger packing needs no oil.

PLUNGER PACKING.—Vapor leaks at this point are sometimes impossible to overcome. An invisible vapor leak will not affect the performance of the pump and no particular effort need be made to eliminate a leak unless it reaches the point where it becomes visible. If a leak should develop at the lower end of the plunger, tighten the plunger guide, shown in figure 8-4, with a rod supplied (approximately 3/8" by 6"). Do not bind the plunger by tightening it too snugly. When it is no longer possible to adjust the tightness of the plunger guide, new packing should be inserted as follows:

1. Remove the compressor body from the frame by unscrewing the four bolts which hold the compressor body to the crosshead guide and remove the pin which holds the plunger to the crosshead.

2. Place the compressor body in a vise, remove the plunger guide and old packing. Insert only the two large pieces of packing and the spacer. Then insert the plunger guide and turn it down as far as possible to compress and form the packing around the plunger. This operation will cause the plunger to bind, but it can be freed by turning and working the plunger up and down a few times.

3. Remove the plunger guide and insert the small ring of the packing. Install so that the level fits the packing already in place and the plunger guide. Replace the plunger guide and turn it in until the maximum dimension between the body at point (A) and end of the plunger guide (B) is 1-3/16 inches. If the plunger guide is not screwed in sufficiently, the crosshead will strike the plunger guide. The plunger can be freed by working it back and forth several times.

4. Replace the compressor body, extending the plunger sufficiently so it can be lined up with the crosshead and the pin be replaced. After connecting the end of the plunger with the crosshead, which may have had to be moved to its top position in order to accomplish the connection, tighten the bolts securely. Turn the master gear for several revolutions by hand to be certain the crosshead does not strike the plunger guide.

SAFETY DISC.—Figure 8-4 illustrates the safety disc arrangement located in the discharge body. The method of removal and replacement of the safety disc is self evident in the illustration; however, never use a disc that

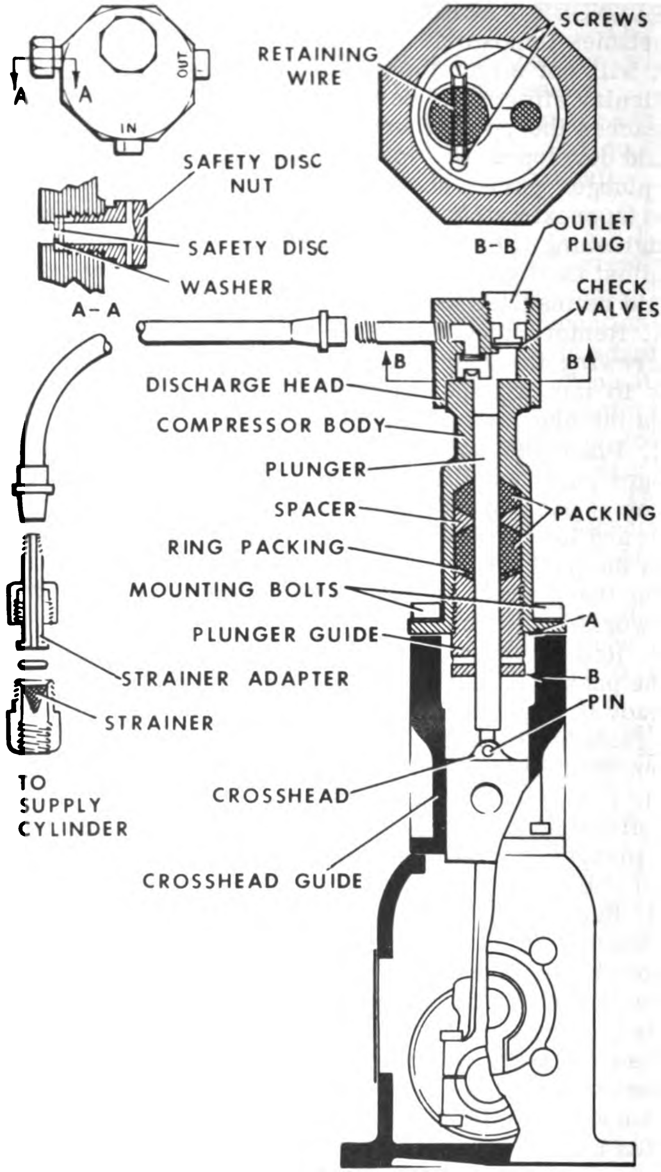


Figure 8-4.—Compressor assembly of the Walter Kidde CO_2 transfer unit.

is stronger or weaker (tensile strength capacity) than specified.

CLEANING.—Recharging pump connections should be kept free of foreign matter. If a decrease is noted in the amount of carbon dioxide transferred (should be approximately 80 percent of the supply cylinder), remove the two check valves (fig. 8-4) in the compressor head and clean. To do this, remove the discharge head body (right-hand thread). Then remove two screws and retaining wire. The inlet check will then be accessible. The outlet check can be removed by unscrewing the plug. Clean both checks and seat thoroughly.

The strainer on the inlet line (from the supply cylinder) should be cleaned frequently for maximum efficiency of the pump.

Periodically tighten all bolts on the compressor head and frame.

QUIZ

1. Carbon dioxide pumps are designed to pump carbon dioxide in its
   a. liquid state
   b. gaseous state
   c. vaporous state
   d. liquid gaseous state

2. Carbon dioxide pumps are capable of transferring what percentage of the liquid in the carbon dioxide supply cylinder?
   a. 20 percent
   b. 80 percent
   c. 60 percent
   d. 40 percent

3. The type of oil used in the crankcase of the C-O-Two pump is
   a. S.A.E. 20
   b. S.A.E. 30
   c. S.A.E. 10
   d. S.A.E. 40

4. The type of oil used in the Walter Kidde carbon dioxide transfer unit is
    a. S.A.E. 20
    b. S.A.E. 30
    c. S.A.E. 10
    d. S.A.E. 40
5. The safety disc is designed to relieve the pressure in the C-O-Two pump at
    a. 2,700-2,900 p.s.i.
    b. 2,650-3,000 p.s.i.
    c. 2,100 p.s.i.
    d. 2,700-300 p.s.i.

6. Before transferring carbon dioxide make sure that
    a. the inlet strainer is clean
    b. all lines and connections are tight
    c. the inlet and outlet check valves are clean
    d. all of the above

7. The crankcase of the C-O-Two pump is drained and refilled every
    a. 6 months
    b. 3 months
    c. year
    d. 2 years

8. After receiving a damaged carbon dioxide transfer unit, you would
    a. repair it
    b. replace the damaged part
    c. fix the damaged part temporarily
    d. return the pump to the supply officer

9. A new carbon dioxide pump should be run in with the
    a. pressure on
    b. liquid carbon dioxide
    c. lines disconnected
    d. lines connected
10. All lines are checked before transferring carbon dioxide because it is transferred under a pressure of
    a. 1,000 p.s.i.
    b. 850 p.s.i.
    c. 1,800 p.s.i.
    d. 300 p.s.i.
11. To prevent expansion of carbon dioxide in the supply hose, and consequently blocking hose with carbon dioxide, the valve should have an outlet opening of at least
    a. 1/8 inch in diameter
    b. 1/4 inch in diameter
    c. 1/2 inch in diameter
    d. 1/3 inch in diameter

12. The oil level in the C-O-Two pump is checked
   a. every day
   b. monthly
   c. quarterly
   d. once a week

CHAPTER 9

AERIAL DELIVERY

Although aerial delivery is not a primary concern of the Navy, it is sometimes necessary for naval aircraft to engage in such operations. Therefore, a Parachute Rigger must be familiar with the various types of aerial delivery equipment.

Types of aerial delivery vary widely, since conditions and circumstances determine the kind of equipment and the types of assemblies to be used. For example, supplies or equipment may have to be dropped to men in life rafts at sea, marooned on an island, in a jungle, or in a mountainous region. At other times it may be necessary to drop equipment behind enemy lines.

The aerial delivery equipment discussed in this chapter is standard U. S. Air Force equipment and is available to naval activities through regular supply channels.

G-1 AND G-1A AERIAL DELIVERY PARACHUTES

The type G-1 and G-1A aerial delivery parachutes are used in conjunction with various containers, cartons, packs, and slings designed especially for handling and enclosing supplies and equipment most likely to be delivered by air.

Canopy Assembly

DESCRIPTION.—The canopies and lift webs for the G-1 and the G-1A cargo parachutes are identical. Different

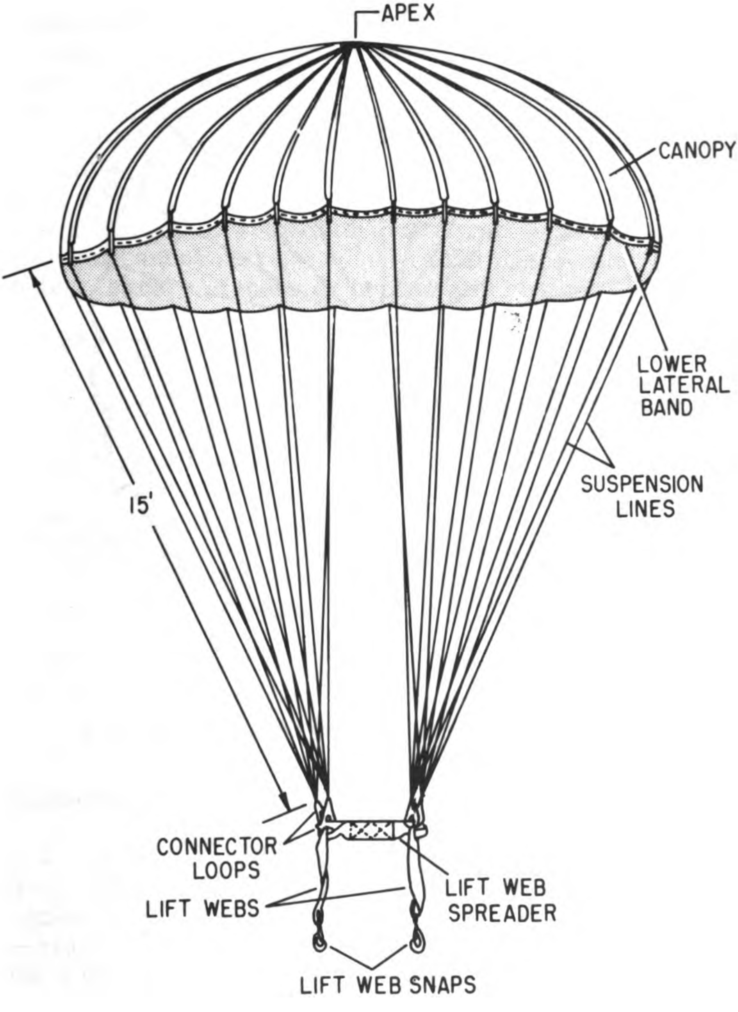


Figure 9-1.—G-1 and G-1A parachutes, showing canopy and lift webs.

packs are used for the type G-1 and the type G-1A parachutes. The pack for the type G-1 is composed of two parts, the pack body and the pack cover, with the static line a part of the cover. The pack for the type G-1A is a

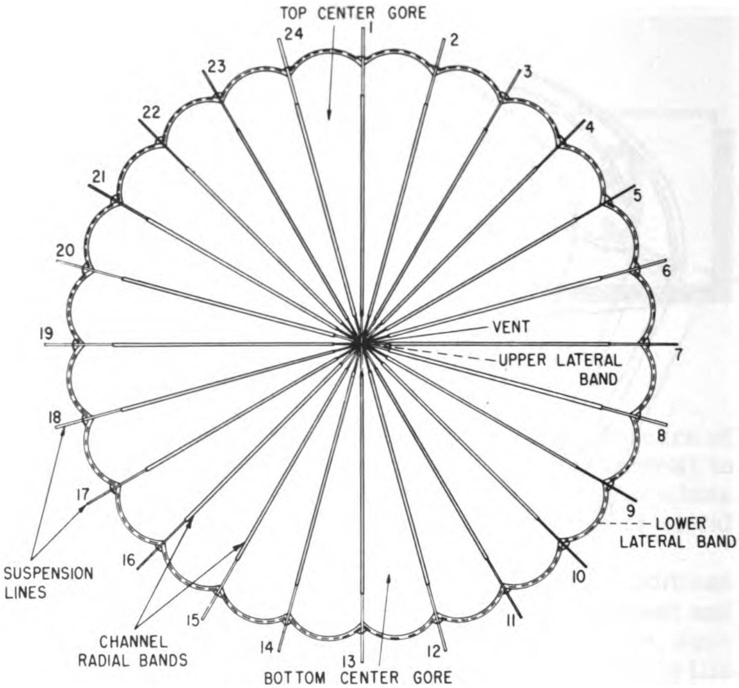


Figure 9- 2.—G-1 and G-1A canopy laidout flat, top view.

one-part unit with the static line forming a separate assembly.

The flat, circular-type canopy shown in figures 9-1 and 9-2 is 24 feet in diameter and has a 12-inch diameter vent at the apex. This canopy is made of 24 one-piece solid rayon gores, and is issued in five different colors—green, light blue, natural, red, and yellow. There is no limitation to the service life of the G-1 or G-1A parachutes.

Lengths of rayon tape, referred to as upper and lower lateral bands, reinforce the assembly by encircling the canopy inside the skirt and vent hems. On some canopies a lower lateral band outer reinforcement is sewed to the inner circumference of the skirt and is looped loosely around each suspension line.

The 24 suspension lines are actually made of 12 lengths of rayon tape, with each length of tape running continuously over the canopy from connector loop to connector loop. Unstitched areas of suspension lines on the canopy are protected by radial bands which form channels for the lines. Two lift webs are separated by a spreader, and the suspension lines are attached to the connector loops.

INSPECTION.—Check the entire surface of each gore for holes, tears, weak spots, and any foreign materials such as mildew, rust, water, oil stains, and battery acid that cause fabrics to deteriorate rapidly. Check each seam at canopy skirt, channel radial bands, and vent for holes, tears, and loose or broken stitching.

Canopy Repairing

RESTITCHING.—Loose or broken stitching areas can be restitched without removing the old stitching. Use natural, size E nylon thread. Stitch 8 to 10 stitches per inch, using Singer Model 31-15 sewing machine or equivalent for the tape.

DARNING.—Darn holes or tears not exceeding 1 inch in length with size E nylon thread. The procedure for darning is the same as given for personal parachutes in *PR 3 & 2,* Volume 1.

RECTANGULAR PATCHING.—Damaged areas that do not extend to any of the gore seams may be repaired with rectangular patches as follows:

1. Turn the canopy inside out and lay it out on the repair table, centering the gore to be patched on the table.
2. Place a patch pattern that is 3 inches longer and 3 inches wider than the damaged area on the material to be used for patching so that the edges of the pattern are parallel to the warp and filler of the material. Mark the material according to the pattern. Cut the patch from the material according to the marking.
3. Fold back the edges of the patch 1/2 inch and baste with thread, using two stitches per inch. Place the patch over the hole to be patched, making sure the warp and the filler of the patch and of the canopy gore run parallel to each other. Baste the patch to the gore, using two stitches per inch.
4. Stitch the patch on the canopy by sewing at the edge of patch, using natural, size E nylon thread. Stitch 8 to

10 stitches per inch, using Singer Model 31-15 sewing machine or equivalent. Place the first row of stitches 1/16 inch from the edge of patch. Sew completely around the patch and overlap the stitches 2 inches to make secure.

Turn the canopy right side out and cut out the damaged material around the hole. Fold under the edges of the material around the hole 1/2 inch and baste. Sew completely around the patch 1/16 inch from edge of the hole, overlapping the stitches 2 inches. Remove the basting and place a third row of stitches between the other two rows. Sew completely around the patch and overlap 2 inches.

CHANNEL-TO-CHANNEL PATCHING.—A large damaged area may be repaired with a channel-to-channel patch up to 5 feet in length. The patch may extend to either the lower or upper lateral band seam, depending on the location of the damaged area.

The procedure is the same as for the rectangular patching with the following exceptions:

If the patch is to cover a lower lateral band that is equipped with a reinforcing tape, remove the stitches and raise the tape so that the patch may be installed under the tape. If the lower lateral band reinforcing tape is loosened, replace with a double row of stitching. Reproduce as closely as possible all stitching that was removed.

REPLACEMENT OF A GORE.—If a channel-to-channel patch cannot be used to repair a gore adequately, the badly damaged gore may be replaced as follows:

1. Remove the suspension line channel radial bands on both sides of the damaged gore.

2. To cut the gore or to prepare a pattern for the gore, refer to figure 9-3. From point A in figure 9-3, measure 12 feet 11 inches along the selvage edge to find point B. From point A, measure 3 feet along a perpendicular to find point C. Connect points B and C. From point B measure 12 feet 11 inches back along line BC to find point D. Connect points D and A. To find line EF, slide a rule back from point B until perpendicular line EF measures 2-3/4 inches. Cut the gore or pattern along lines ADEF. In cutting the gore, line AB must always lie along the selvage edge or parallel to it.

3. Install the new gore, adapting the procedure given for channel-to-channel patching. Replace the suspension line channel radial bands.

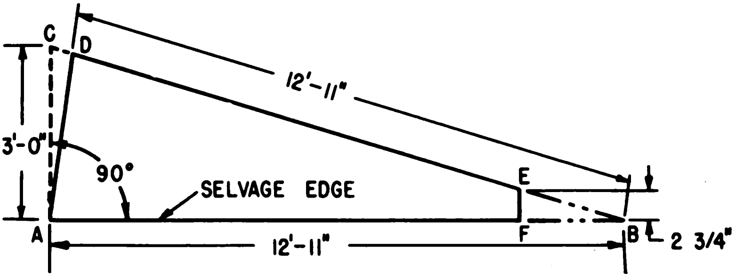


Figure 9-3.—Canopy gore dimensions, including seam allowance.

SPLICING THE LOWER LATERAL BAND.—The lower lateral band is made of natural, 1-inch wide, type I rayon tape. The lower lateral band outer reinforcement is made of natural 1/2-inch wide, type II rayon tape. Tape joints overlap 5 inches and are stitched with 4 rows of stitching.

The lower lateral band may be spliced with a new length of rayon tape, extending one-half the width of gores adjacent to damaged gore. Dip ends of tape in a mixture of 50 percent paraffin and 50 percent beeswax to prevent fraying. Stitch with a zigzag sewing machine, using type E nylon thread. Stitch 8 to 10 stitches per inch, 1 row of stitches on each side of center of rayon tape. Do not crowd stitches, backstitch the zigzag stitching, nor overlap rows of stitching.

REPAIRING V-TABS.—The V-tabs are short lengths of natural, 1/2-inch wide, type II rayon tape, which reinforce the suspension lines at the lower lateral band. Loose or broken stitching is restitched, using size E thread.

To replace several V-tabs, remove stitching that holds the tab to lower lateral band and outer reinforcement. Install the new tab, using 8 to 10 stitches per inch.

REPAIRING UPPER LATERAL BAND.—The upper lateral band is made of two thicknesses of a length of natural, 1-inch wide, type I rayon tape, which is bound by a folded length of the same type rayon fabric used for the gores. This rayon binding is joined together with a 3/4-inch overlap with the ends of the binding turned under 1/4 inch. The tape is joined together with a 5-inch overlap and is stitched with 4 rows of stitches.

Splicing the upper lateral band is accomplished in the same manner as given for splicing the lower lateral band. The upper lateral band is not replaceable.

REPAIRING SUSPENSION LINES.—The 24 suspension lines are made of 12 lengths of natural, 1/2-inch wide, type II rayon tape. Each length of tape is approximately 56 feet 10 inches long when measured under a 10-pound tension. Each suspension line is 15-feet long from the edge of serving on the connector loop to the skirt of the canopy.

Splicing the suspension line is done in the same manner as given for splicing the lower lateral band.

Suspension lines may be replaced as follows:

1. Remove stitching that secures the damaged line to canopy and the connector loops. Remove servings and tape at appropriate connector loops and remove damaged line.

2. Place new suspension line under a 10-pound tension and cut a 57-foot 4-inch length. The length of the new suspension line is 6 inches longer than the required length of the suspension line to allow for any margin of error, since other undamaged lines may have been stretched with use of the parachute.

3. Dip the ends of new line in a paraffin-beeswax mixture. Place the line through the proper channel radial bands on the canopy.

4. Place the new line in proper position with the other lines at connector loops. Lay parachute out on the packing table and apply equal tension to new and old suspension lines.

5. Form a 3-inch loop, making certain that any excess line is cut off before final sewing and serving; using 5 to 7 stitches per inch on a 7-31 sewing machine to secure the lines. Wrap the loop with 1-inch wide adhesive tape. Make two 1-inch servings 5 inches apart using cotton 6 cord.

REPAIRING LIFT WEBS.—The lift web assembly consists of two 34-inch long webs and a spreader made of natural, type VIII, cotton webbing. Lift web snaps are attached to the ends of the lift webs.

Lift webs, spreader, and snaps should not be repaired. The lift web assembly may be replaced as follows:

Fabricate lift webs with type VIII cotton webbing and attach as shown in figure 9-4. Stitch 6 to 8 stitches per inch, using a 7-31 sewing machine.

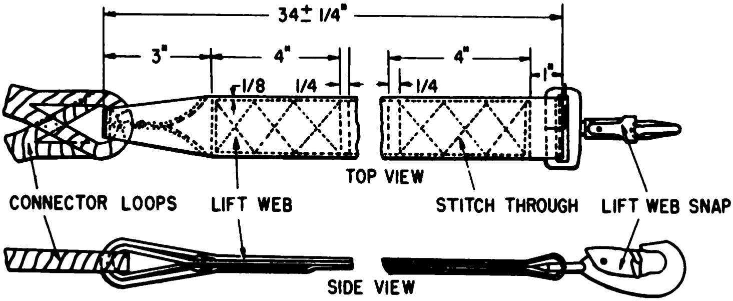


Figure 9-4.—Lift web, top and side views.

Fabricate the lift web spreader from the same type webbing, and attach as shown in figure 9-5. Use same stitches and sewing machine as for the lift web.

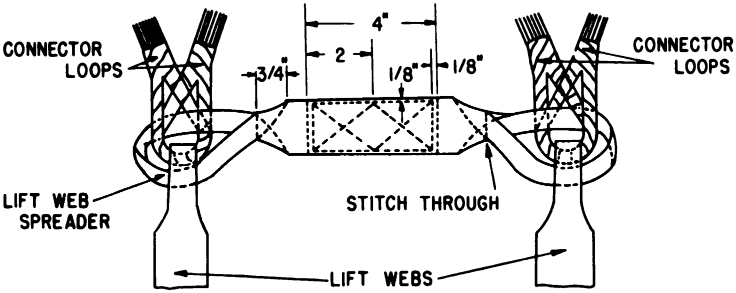


Figure 9-5.—Lift web spreader, showing method of securing to lift webs.

G-1 Pack

DESCRIPTION.—The G-1 pack consists of two main parts, the pack body and the pack cover. A 15-foot static line is attached permanently to the cover.

PACK BODY.—The pack body is 12 inches square and 3-3/4 inches high with an open end. The bottom consists of inner and outer squares of heavy duck, with an enclosed plywood base for easier handling. There are nineteen 1/4-inch brass grommets and one 3/8-inch brass grommet around the open end edge of the side of the pack body. Tiedown webs are sewed to the inner bottom of the pack body with web ends passing through the corners of the pack body.

PACK COVER.—The pack cover is 12-1/8 inches square and 6-1/2 inches high with an open end which fits over the pack body. There are sixteen 1/4-inch brass grommets and four 3/8-inch grommets around the edge of the side of the pack cover. The larger grommets are located where the ends of the static line webs meet the edge of the pack cover. The static line webs are sewed to the inside of the pack cover. The 15-foot static line is looped through the pack cover and around the static line webs where the webs cross at the loop hole in the pack cover top. Figure 9-6 shows the inside of the pack body and cover.

REPAIRING PACK BOTTOM AND COVER.—Restitching and darning the pack bottom and cover may be done by following the same procedure as for restitching and darning the canopy. Holes or tears that are more than 3/4 inch in diameter or length require patching. Patch the side or bottom with the same type material used in the original construction. The type of patch used depends on the location and the extent of the damage. When patching, use 6 to 8 stitches per inch with a 111 W 151 sewing machine or equivalent.

PARACHUTE LOG RECORD PACKET.—The parachute log record pocket is located in the bottom of the pack body, and is made of the same material as the pack body side and bottom. There is a pull tape for ease of removing the packing card. The binding tape and pull tape are made of 3/4-inch, type III, cotton reinforcing tape.

STATIC LINE.—The static line is made of natural, type VIII, cotton webbing and is provided with a static line snap. The static line should not be repaired; it should be replaced.

Replace the static line by removing the damaged line from pack cover and fabricating and installing a new line. Use 6 to 8 stitches per inch, using a 7-31 sewing machine.

G-1 Pack and Static Line

DESCRIPTION.—The G-1A pack and static line, unlike the G-1 pack and static line, are separate assemblies.

PACK.—The G-1A pack is a single unit, consisting of a cotton duck side panel and inner and outer bottom panels. (See figs. 9-6 and 9-7.) The four cover flaps are part of the same piece of duck as the side panel, with the cover loops formed from the cover loop strap. A top reinforcing strap is attached to the outside of the pack beneath the flaps, with two static line retaining straps attached to the top reinforcing strap. Two suspension line retaining band keepers are attached to the inner bottom panel, and four pack tiedown straps are attached near the four bottom corners.

STATIC LINE.—The static line is a mildew-proofed, 15-foot 4-inch length of olive drab, type VIII cotton webbing with a snap at one end, an attaching loop at the other end, and a pack opening loop 4-3/4 inches from the attaching loop.

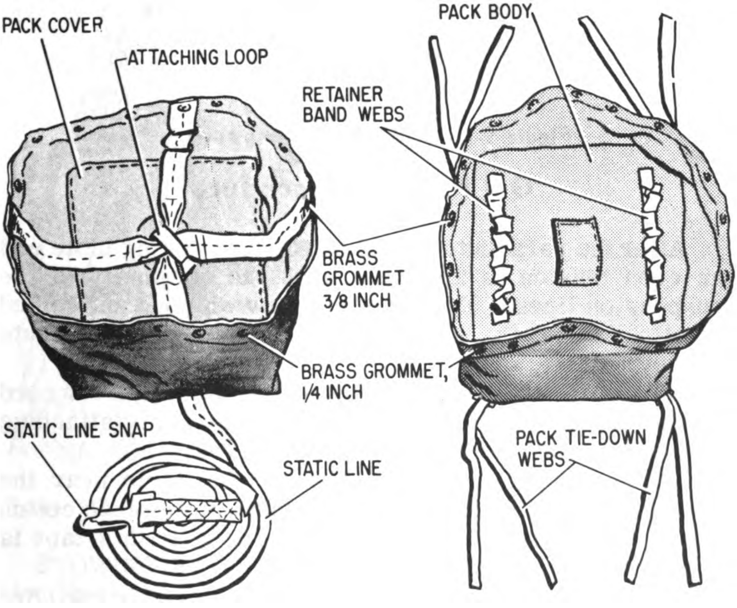


Figure 9-6.—G-1 pack body and cover, showing inside view.

REPAIRING.—The restitching, darning, and patching is done in the same manner as given for the G-1 pack.

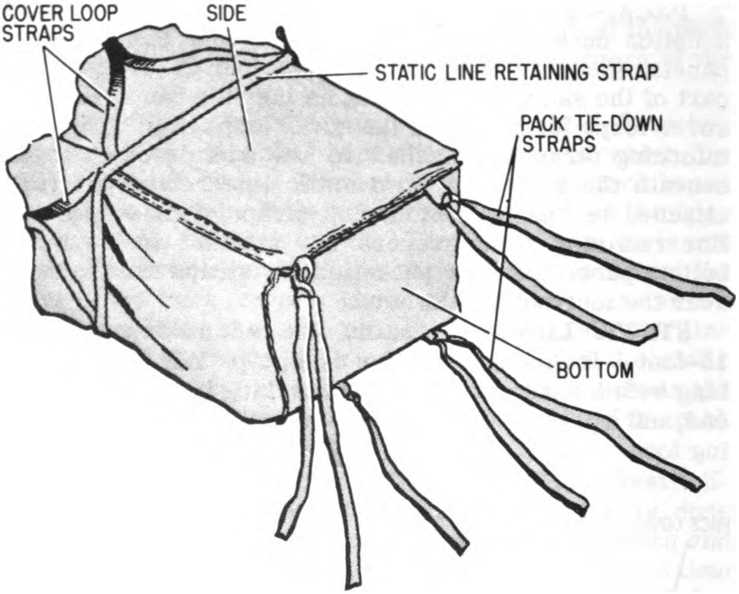


Figure 9-7.—G-1A pack showing outside.

G-1 Packing Procedure

After the parachute is laid out on the packing table and an even tension is applied, check the continuity of the suspension lines. The canopy is now whipped and folded identically to the personal man-carrying parachute canopy.

ATTACHING BREAK CORD.—To attach the break cord to the canopy bridle loop and the break cord attaching loop of the static line, proceed as follows:

Place the pack cover on the packing table near the canopy apex. Obtain a 24-inch length of 1/4 inch cotton tape. Three turns of 6 cord may be used if this tape is not available.

As shown in figure 9-8, pass one end of break cord through bridle loop. Place the two ends together and stretch break cord taut. Pass each running end of break cord through attaching loop on static line from opposite directions. Tighten break cord so that loop formed by break cord is approximately 3 inches in length. Tie ends together with a surgeon's knot and a square knot, then tie ends around the break cord with 3 alternating half-hitches.

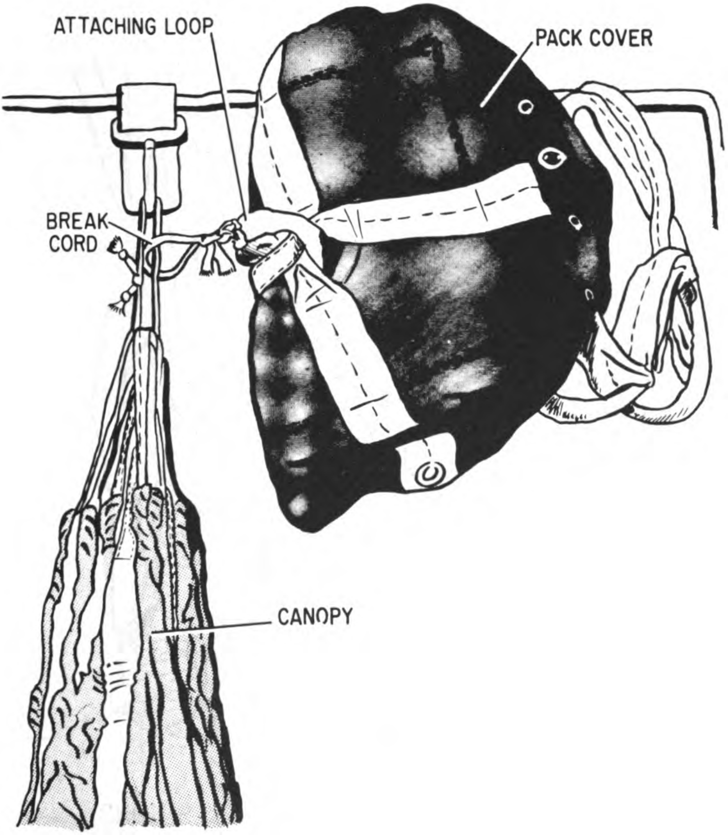


Figure 9-8.—Break cord attached to bridle loop and attaching loop.

STOWING SUSPENSION LINES.—To stow the suspension lines, release the tension on the lines and canopy; then place the lift webs, spreader, and connector loops on the pack body.

Arrange the suspension lines the width of the pack body, with the first stow at lower left and the second stow at lower right. Secure the stows with the retainer rubber bands attached to the suspension line retainer band webs. (See fig. 9-9.) Continue this procedure until the suspension lines are stowed, leaving 12 to 14 inches of suspension lines between the last stow and the canopy skirt.

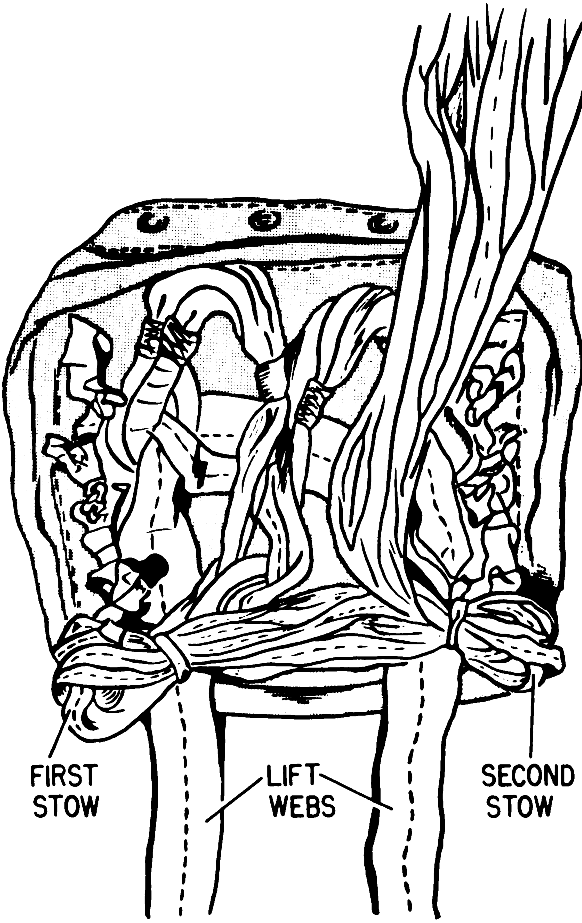


Figure 9-9.—Suspension lines, showing first and second stows.

PACKING CANOPY.—To pack the canopy, unhook the bridle loop from the table and remove the shot bags. Pack the canopy on the pack body in the same manner as packing a man-carrying parachute, using accordion folds. The edges of the folded canopy are to be kept the same width and length as the pack body.

CLOSING PACK.—To close the pack, draw pack cover down over the folded canopy and pack body. As shown in figure 9-10, lace the pack body and pack cover loosely by passing two turns of 6 cord through opposite grommets of pack body and pack cover sides. Tighten lacing so that pack cover fits snugly over pack body, grommet over grommet, and tie ends of 6 cord together with surgeon's knot and a square knot.

Accordion fold the static line in folds approximately 12 inches long and hold with rubber retainer band. The G-1 cargo parachute assembly is now packed and ready for use as shown in figure 9-11.

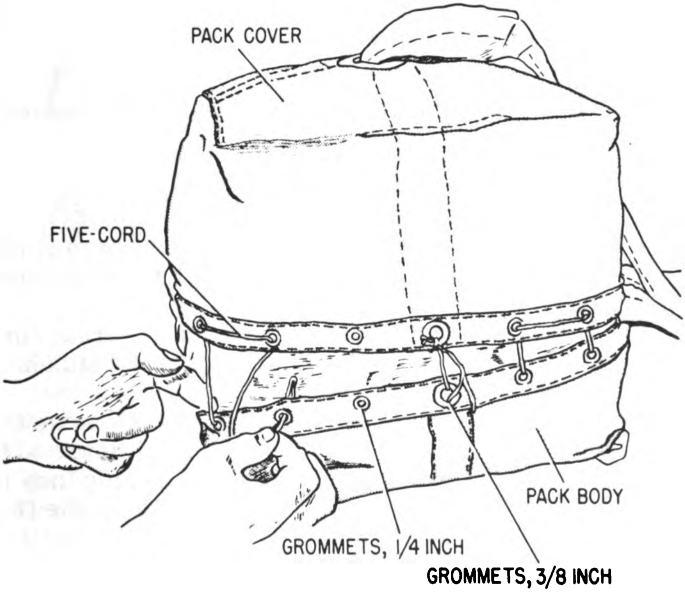


Figure 9-10.—Closing the G-1 pack, showing cover being laced loosely to the body.

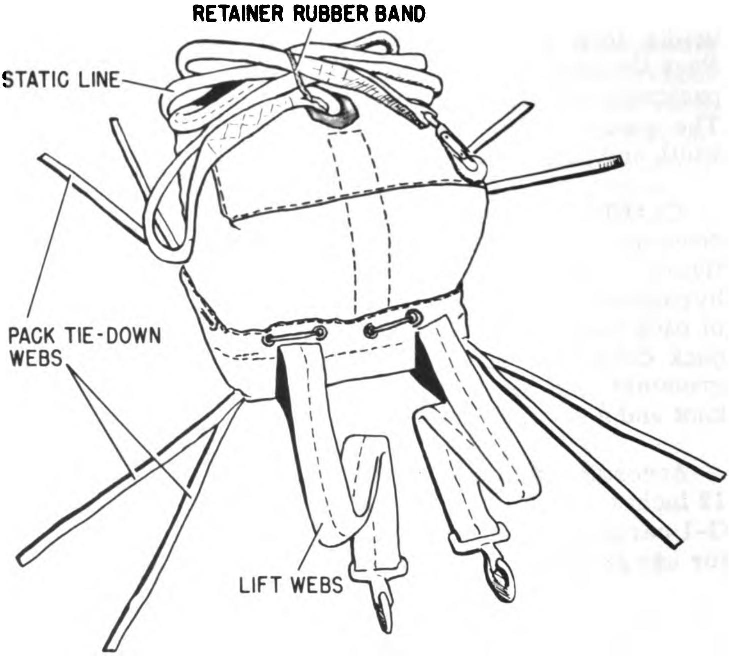


Figure 9-11.—The G-1 cargo parachute assembly, packed and ready for use.

G-1A Packing Procedure

To whip and fold the canopy of the G-1A cargo parachute, follow the same procedure as for the G-1 cargo parachute.

ATTACHING BREAK CORD.—To attach the break cord to the canopy bridle loop and the break cord attaching loop of the static line, proceed as follows:

Place the static line (separate unit) on table near the canopy apex. Using 1/4-inch tape or 6 cord, make a 3-inch loop securing the bridle loop to the attaching loop in the same manner as attaching the break cord for the G-1 cargo parachute. (See fig. 9-12.)

STOWING SUSPENSION LINES.—To stow the suspension lines in the pack, release the tension on suspension lines and canopy. Open the pack and roll down the side of the pack to aid in stowing of lines.

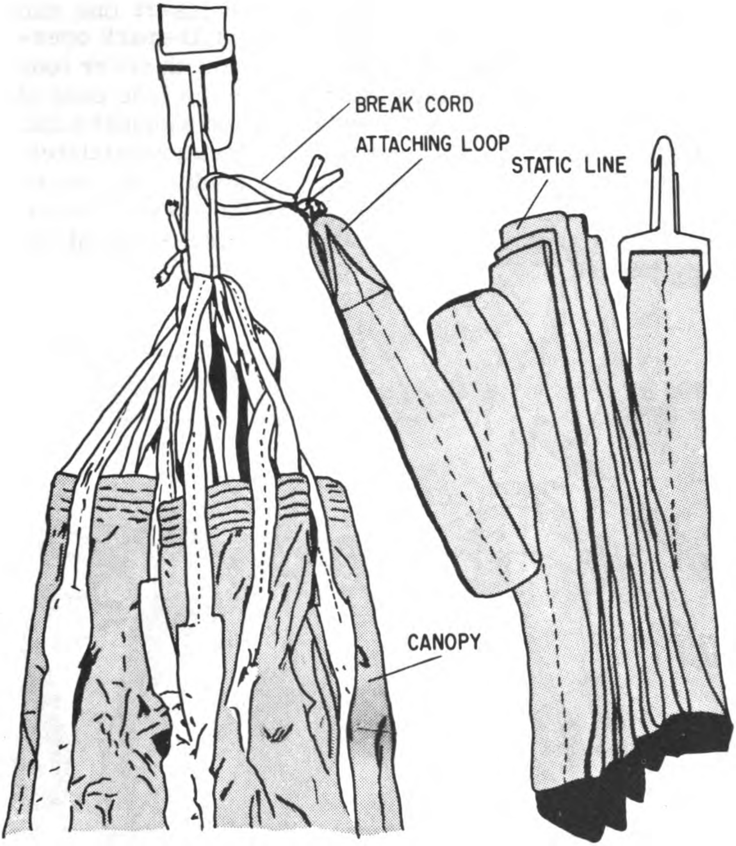


Figure 9-12.—G-1A break cord attached to bridle loop and attaching loop.

Place lift webs, spreader, and connector loops over the rubber bands attached to the suspension line retainers on the false bottom of the pack. Stow the suspension lines, following the procedure given for the G-1 cargo parachute.

PACKING CANOPY.—To pack the G-1A canopy, adapt the procedure for packing the G-1 canopy.

CLOSING PACK.—To close the pack, proceed as follows:

Fold cover flaps over the canopy, making certain that the static line emerges from side of pack opposite the lift webs.

Take a length of 1/4-inch tape and insert one end through three cover loops on flaps, through the pack opening loop on static line, and through the fourth cover loop (fig. 9-13). Draw the tape tight and tie the free ends of the tape together with a surgeon's knot and a square knot.

Fold the static line in accordion folds approximately 12 inches long. Stow on top of pack, holding the stows with retainer rubber bands attached to the retainer webs. Figure 9-14 shows the G-1A cargo parachute packed and ready for use.

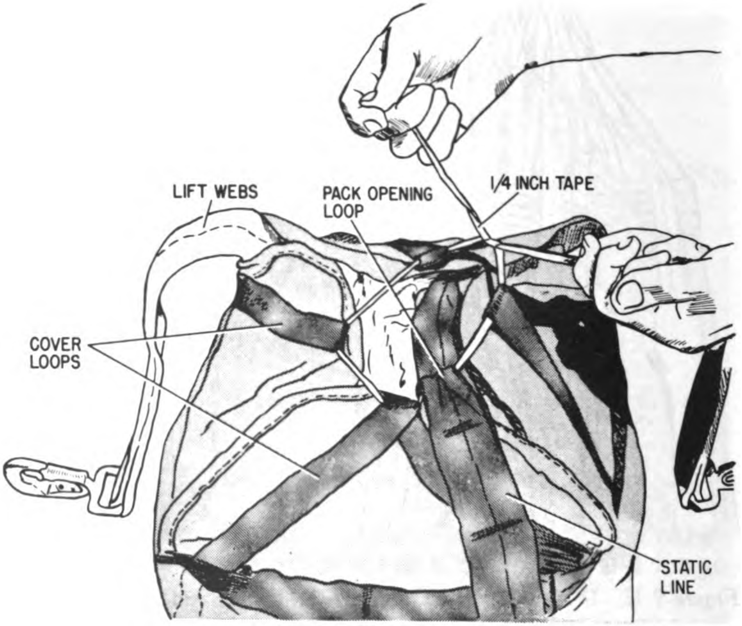


Figure 9-13.—Closing the G-1A pack.

MISCELLANEOUS AERIAL DELIVERY CONTAINERS

The occasion may arise when cargo parachutes and rigs have to be improvised. With a few adaptations, surveyed man-carrying type parachutes may be used for aerial delivery. All such parachutes must be stenciled

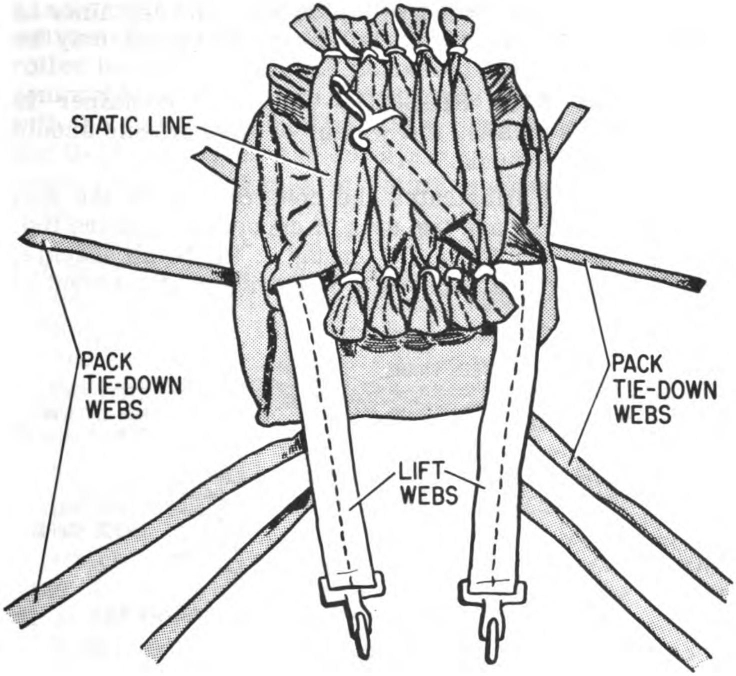


Figure 9-14.—The G-1A cargo parachute, packed and ready for use.

"CARGO" in large letters to assure that the units are never returned to man-carrying service.

Type A-4 Container

The type A-4 aerial delivery container consists of an adjustable canvas container and a suspension harness made from webbing. The container is approximately 12 x 24 x 30 inches in size when fully loaded.

One end of the container is open for loading, and is closed by means of flaps laced together with cord. The other end is equipped with sets of tape for tying up excessive fabric after the container has been loaded. The top is equipped with webbing straps and V-rings for attachment of the parachute, and is reinforced with a steel frame containing two steel loops for engaging the bomb shackle.

The bottom is reinforced with plywood. The container is furnished with two corrugated fiber boxes. It may be used with or without the boxes.

PACKING AND RIGGING.—When the container is packed with supplies, the weight of the contents should not exceed 200 pounds.

Figure 9-15 illustrates the construction of the A-4 container. There are two sets of connections on the top; one pair of steel loops for engaging the bomb shackle, and a pair of web straps with V-rings for attachment of the parachute.

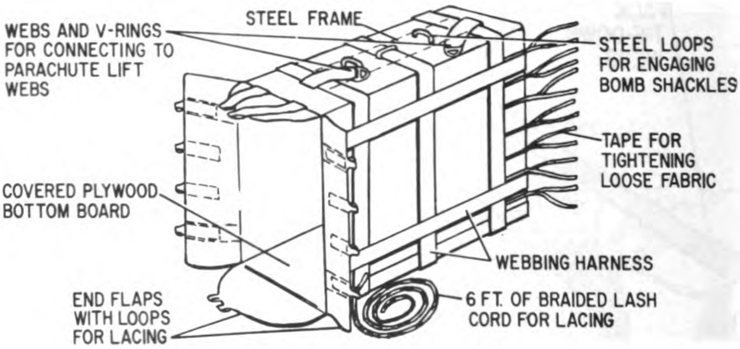

WEBS AND V-RINGS FOR CONNECTING TO PARACHUTE LIFT WEBS
STEEL FRAME
STEEL LOOPS FOR ENGAGING BOMB SHACKLES
TAPE FOR TIGHTENING LOOSE FABRIC
COVERED PLYWOOD BOTTOM BOARD
WEBBING HARNESS
END FLAPS WITH LOOPS FOR LACING
6 FT. OF BRAIDED LASH CORD FOR LACING

Figure 9-15.—Type A-4 aerial delivery container assembly.

When the container is loaded, the open end is closed by lacing with the 6-foot length of braided cord furnished with the container. Tighten the excess fabric by tying the pairs of webbing tapes together at the other end of the container. The parachute assembly is tied to the end of the container, and the tie-tapes of the parachute pack are passed around the container harness webbing.

Snap the lift webs of the parachute to the V-rings on the web straps at the top of the container. To prevent the lift webs from pulling out of the pack under slipstream pressure, tack the webbing to the pack.

Type A-5 Container

The type A-5 aerial delivery container consists of a heavy sheet of canvas 15 feet long by 56 inches wide, with a pad of felt 40 inches wide running down the center. The canvas edges fold inward over the load, and the unit is rolled into a roll about 18 inches in diameter over which removable end flaps are fitted. It is used in conjunction with the standard aerial delivery parachutes, types G-1 and G-1A. The type A-5 container was developed for the aerial delivery of rifles and similar equipment and supplies.

PACKING AND RIGGING.—Place the container roll flat, with the rifles placed about 12 inches apart down the center with the butts alternating. The container will accommodate about 12 Model M-1 rifles to a roll. The spaces between the rifles are filled with ammunition.

Fold the canvas flaps at the outer edges over the ends of the rifles and roll the container about the equipment to make a compact roll. Draw the end caps over the ends of the roll and secure by fastening the adjustable webbing together, using bayonet fittings or snap hooks. Tighten the webbing to suit the load.

Attach the parachute to either end of the container by tying the tapes on the corners of the pack to the tabs on the end of the container cap.

Hoop the lift webs of the parachute to the V-rings and tack the webs to the edge of the end cap.

Type A-6 Container

The type A-6 aerial delivery container consists of a corrugated fiber carton, into which the contents are packed; a canvas cover, fitting over and protecting the carton; a webbing sling or harness, for suspending the container to the parachute assembly; and a shock-absorbing pad, attached to the bottom of the container.

This container is used in conjunction with the standard aerial delivery parachutes, types G-1 and G-1A, for the delivery of miscellaneous supplies and equipment. The dimensions of the corrugated fiber carton are 12 x 12 x 30 inches. Figure 9-16 shows three plastic water bags packed in the A-6 container.

Type A-7 Container

The type A-7 aerial delivery container consists of an adjustable webbing sling developed specifically for use in

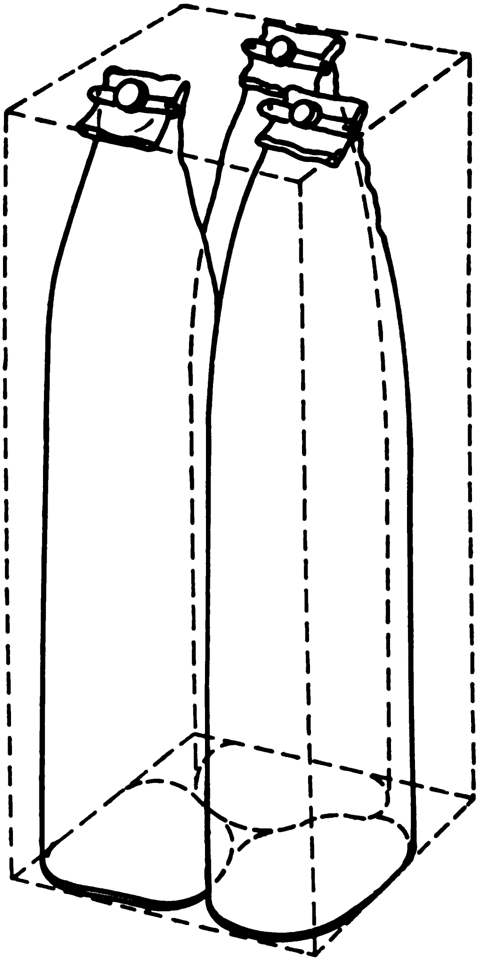


Figure 9-16.—Three plastic water bags packed in the A-6 container.

deliverying 30-, 45-, and 50-caliber arms and 37-mm ammunition. However, since this sling is adjustable, it can be adapted readily for the delivery of other supplies, including standard 5-gallon cans of water or gasoline, as shown in figure 9-17. The type A-7 container is also used with the G-1 and G-1A parachute.

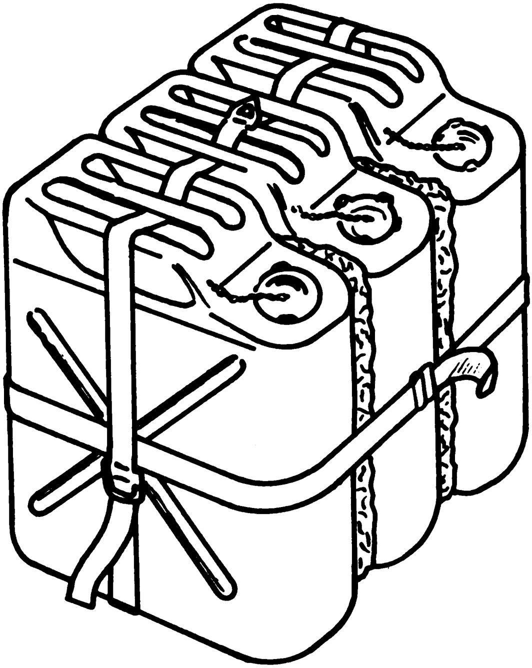


Figure 9-17.—The A-7 adjustable sling and the sling adapted to three 5-gallon cans.

PACKING AND RIGGING.—The webbing sling is strapped around the standard ammunition box, or other load, with the V-ring on top. When the sling is used with three 5-gallon cans, padding should be inserted between the cans.

Attach the parachute assembly on either side of the load by tying the tapes on the pack corners to the webbings on top and bottom of the load. Hook the lift webs of the parachute to the V-rings on top of the sling.

Type A-8 Container

The A-8 aerial delivery container consists of a rigid, octagon-shaped, collapsible container constructed of reinforced fiberboard. The container is 50 inches long and

18 inches in diameter. It is intended for delivery of rifles, and is used with the type G-1 and G-1A parachute.

Type A-9 Container

The type A-9 aerial delivery container consists of an adjustable webbing sling developed for the aerial delivery of 60-, 75-, and 81-mm fiber ammunition cases, and is used in conjunction with the standard type G-1 and G-1A delivery parachute.

Type A-10 Container

The type A-10 aerial delivery container consists of a cargo net approximately 9 feet square. It is intended for delivery of miscellaneous equipment of suitable size and is also used with the type G-1 and G-1A parachute.

Type A-3 Container

The type A-3 aerial delivery container consists of a 5-gallon capacity metal can. A canvas cover extends beyond the top of the can to form a holder for the parachute canopy.

The extension of the canvas cover beyond the bottom of the can provides a pocket for a shock-absorbing landing pad. A pack cover is provided to fit over the parachute pack, and to this cover a static line is attached. The bottom of the canvas cover is closed by means of a 50-foot rope weighted with a 5-pound sandbag. This weighted rope uncoils during the drop but remains attached to the bottom of the unit for retrieving in the event of tree landings.

When the container is filled, the canvas cover is drawn completely over the can and the shock-absorbing pad is placed under the bottom.

PACKING AND RIGGING.—Close the bottom of the canvas cover by lacing the free end of the 50-foot line through the grommets, drawing up tight, and securing with a bowline knot. The canopy is whipped and folded in the usual manner. Attach one group of line to each of the 4 webbing loops. Lay the suspension lines in folds on the sewed-in canvas flap forming the bottom of the parachute pack portion of the canvas cover. The folded canopy is laid in accordion folds on top of the suspension lines.

Tie a 100-pound cord about 12 inches in length to the webbing loop inside the pack cover. Tie the free end of the pilot chute connector cord, from which the pilot chute has been removed, to the 100-pound cord loop, using a bowline knot.

Tie the loose end of the sandbag to the top webbing loop aligned with the D-rings on the outside of the container cover by passing a single turn of 6 cord through the grommet in the sand bag, through the webbing loop, and through the loop inside the pack cover. Tie the sandbag rope to the webbing at each end of the D-ring, using one turn of 6 cord. Coil the remainder of this rope and tie in the bottom of the assembly.

Pull the pack cover down over the assembly and fasten by threading one turn of 6 cord through the webbing loops on the pack cover and through the second row of webbing loops on the container cover.

Launching Instructions and Restrictions

AERIAL DELIVERY CONTAINERS, TYPES A-4, A-5, A-6, A-7, A-8, A-9, A-10, AND A-3.—To reduce as much as possible the risk of damage to the loads, aerial delivery containers should be dropped at a maximum speed of 150 miles per hour, and at a minimum altitude of 300 feet.

All containers of this type can be manually launched from openings in the aircraft. When they are launched from openings in the aircraft, the entire 15 feet of static line is utilized.

All aerial delivery containers, with the exception of types A-7 and A-10, can be launched from internal or external bomb racks. When they are launched from internal bomb racks, the full 15 feet of the static line is used. When launching from external bomb racks, the static line is shortened to 10 feet by winding the line around the bomb shackle attachment so that it does not interfere with the launching mechanism.

Aerial delivery containers, types A-5 and A-9, are equipped with D-rings for engaging bomb shackles. These containers can be launched from bomb racks when the dimensions of the load are such that these D-rings are spaced to fit standard bomb shackles. It is absolutely essential that the free end of the static line be attached to some structural member of the airplane.

The rates of descent of the standard aerial delivery parachutes, types G-1 and G-1A, are illustrated on the graph shown in figure 9-18.

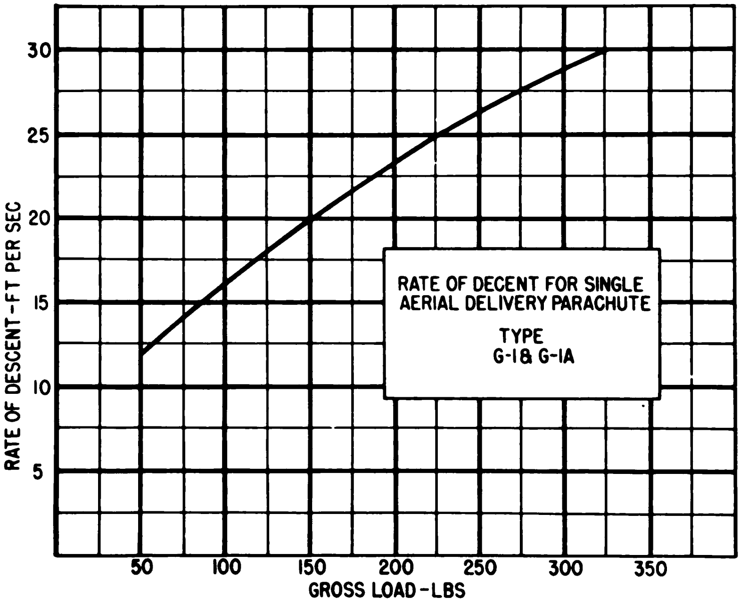


Figure 9-18.—Rates of descent for single aerial delivery parachutes.

Identification of Aerial Delivery Loads

A system for distinctive marking of aerial delivery units is advisable to enable personnel to determine quickly the contents and destination of various loads. This is most important with unit type delivery models. Different loads may be marked for identification in a number of ways, the most satisfactory of which is by the use of different colored canopies. To further facilitate identification of loads, a system of large numbers, either stenciled or sewn on the canopies, may be employed.

COLORED LIGHTS.—The Type A-1 Identification Lamp Assembly, Specification No. 94-32355, consists of a plastic cylinder about the size of an ordinary flashlight. A flashlight lamp socket is located at each end, over which may be placed clear or colored translucent plastic caps of red, yellow, blue, or green. One of the lamp socket fixtures unfastens to permit loading the cylinder with three standard flashlight batteries.

Attached to the outside of the cylinder are two metal loops for attaching the lamp to the load. At one end of the cylinder is a spring contact switch, equipped with an insulating fiber separator to hold the switch open, except when the light is in actual use.

After the lamp cylinder is loaded with batteries and any combination of colored caps, the lamp is fastened to the side of the load. The cylinder is fastened to the load by means of passing tape through the metal loops on the lamp and tying to the lower set of grommets on the parachute pack.

In order for the light to function, the insulating fiber separator must be removed from the switch. Pass a strand of 6 cord through the perforated hole in the separator and tie the other end to a grommet of the pack cover in such a manner that when the load is dropped and the pack cover is pulled from the pack, the separator will be disengaged from the switch and the light will operate automatically.

EXTRACTION PARACHUTE

The extraction parachute consists of a 15-foot diameter extraction canopy, suspension lines, and connector links. The canopy is a wide-ribbon-type constructed of rayon. Also included in the assembly are a 40-foot extraction line, with one shear strap cutting knife, and a 15-foot extraction parachute canopy deployment bag.

Packing Procedure

LAYOUT AND INSPECTION.—Before the extraction parachute is inspected and packed in the deployment bag, it must be properly laid out on the packing table. The extraction parachute assembly is inspected immediately after completion of layout for damage, missing components, and foreign materials that may cause deterioration of the material. The inspection of the canopy is accomplished in the same manner as the inspection of any parachute canopy.

Inspect the entire length of the extraction line for pulled threads, torn areas, loose stitching, damaged seams, and foreign material. Make certain that the cotton buffers inside the connector link loops, the extraction bar loop, and the shear strap cutting knife loop are present and in good condition.

The deployment bag is inspected for tears, rust and other stains, foreign material, loose stitching, and damaged seams. Make certain the following items are present and in good condition: Bag closing loops, bridle loop straps, tiedown straps, inside tabs, and suspension line retainer webs.

FOLDING CANOPY.—Apply even tension on the canopy and suspension lines and check the continuity of the suspension lines. With the exception of the wide-ribbon-type construction of the canopy, it is whipped and folded the same as a solid constructed canopy.

To fold the wide-ribbon-type canopy in the long fold, remove the shot bags and fold the panel section of the right-hand group over the panel sections of the left-hand group, holding them down with the same shot bag. As shown in figure 9-19, fold the panel sections of the left-hand group over the panel sections of right-hand group. This completes the long fold and the canopy is ready to be packed into the deployment bag.

PACKING CANOPY.—To pack the canopy into the deployment bag, release the tension on the suspension lines and unhook the vent from the table. Insert the vent lines into the open end of the deployment bag and pull the vent lines through the vent line hole.

Tie a 6-inch loop of cord through the extraction vent lines. Fold the canopy in accordion folds from side to side of the deployment bag until the entire canopy is packed in the bag. Hold the suspension lines across the last fold of the canopy. Locate the two inside tabs and tie them to each other with a turn of 6 cord.

STOWING SUSPENSION LINES AND EXTRACTION LINE.—Arrange the suspension lines into accordion folds the width of the deployment bag, with the first stow at the upper right and the second stow at the upper left. Continue

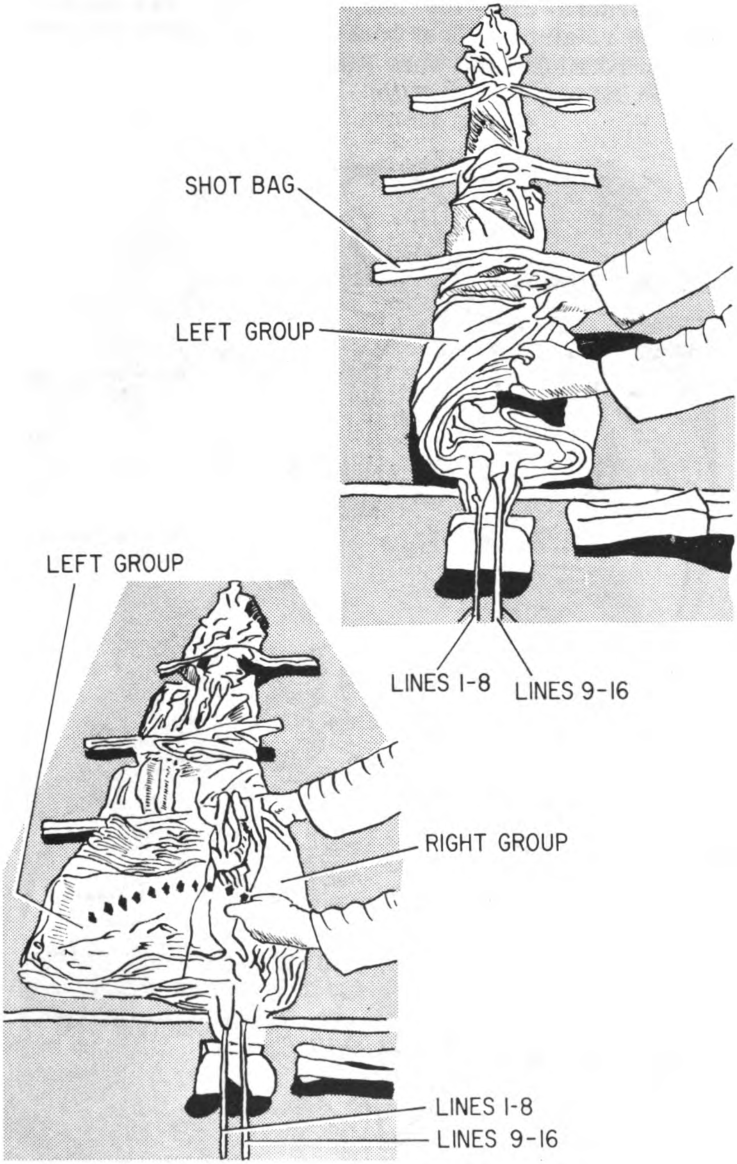


Figure 9-19.—Folding panel sections into long fold.

this procedure until the suspension lines are stowed, using the retainer rubber bands attached to the suspension line retainer band webs. (See fig. 9-20.)

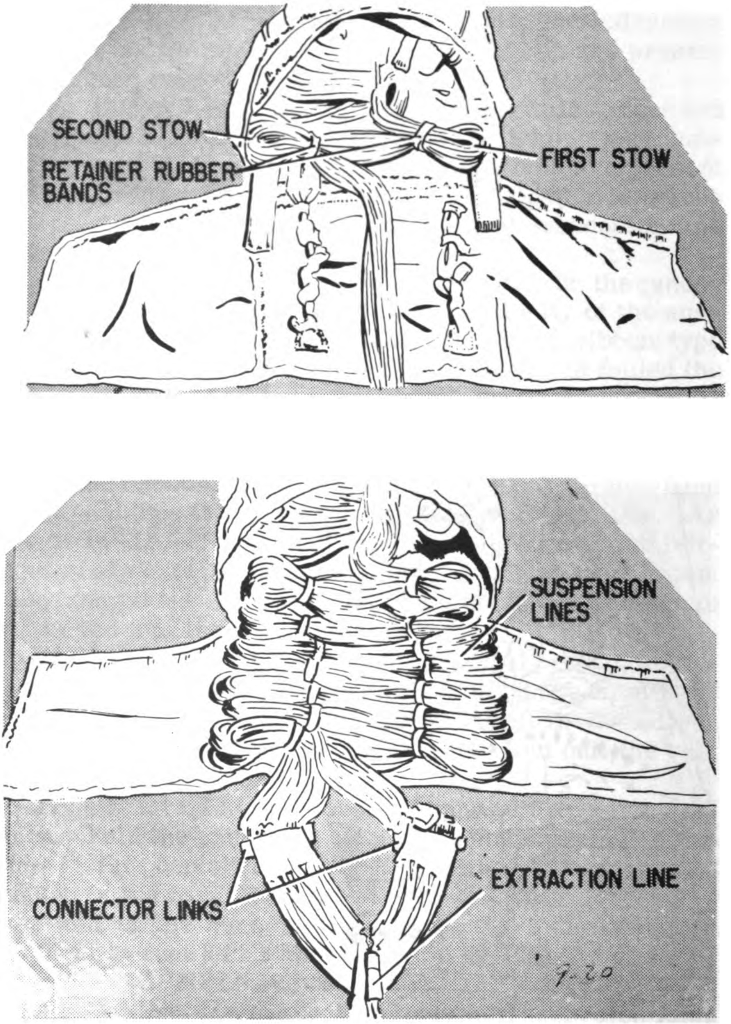


Figure 9-20.—Stowing suspension lines into the deployment bag.

Beginning 18 inches from the connector links, fold half the extraction line in 2 equal groups of 10-inch stows and hold stows of each group together with retainer bands. As shown in figure 9-21, stow the two groups of folded extraction line in the deployment bag.

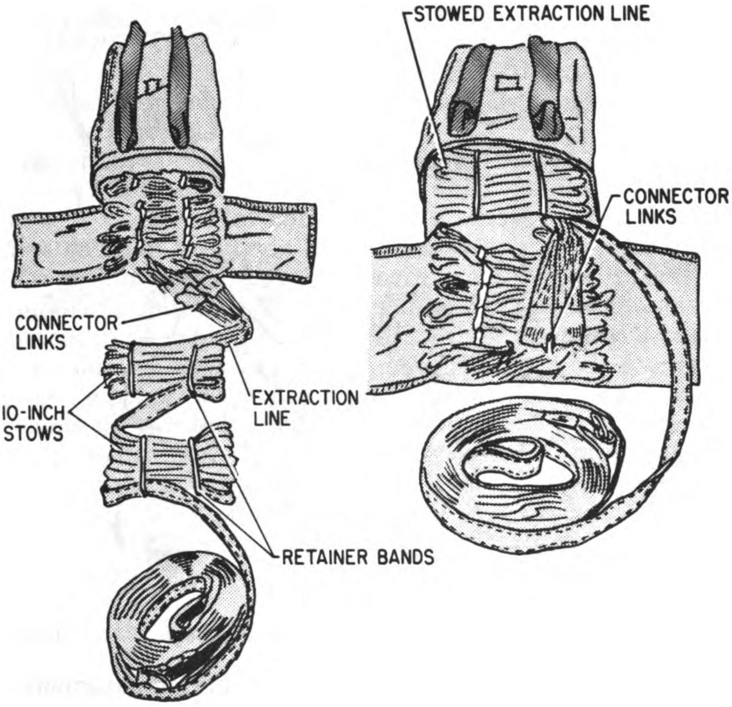


Figure 9-21.—Stowing extraction line into the deployment bag.

CLOSING DEPLOYMENT BAG.—To close the deployment bag refer to figure 9-22, and proceed as follows:

Fold the right-hand end flap over the stowed suspension lines, then fold the left-hand end flap over the right-hand end flap, and tack the flaps together. With the extraction line extending from the right, tightly roll the flaps and tuck into the deployment bag. Pass the extraction line across the deployment bag from right to left, and tie opposite closing loops together with two turns of 6 cord.

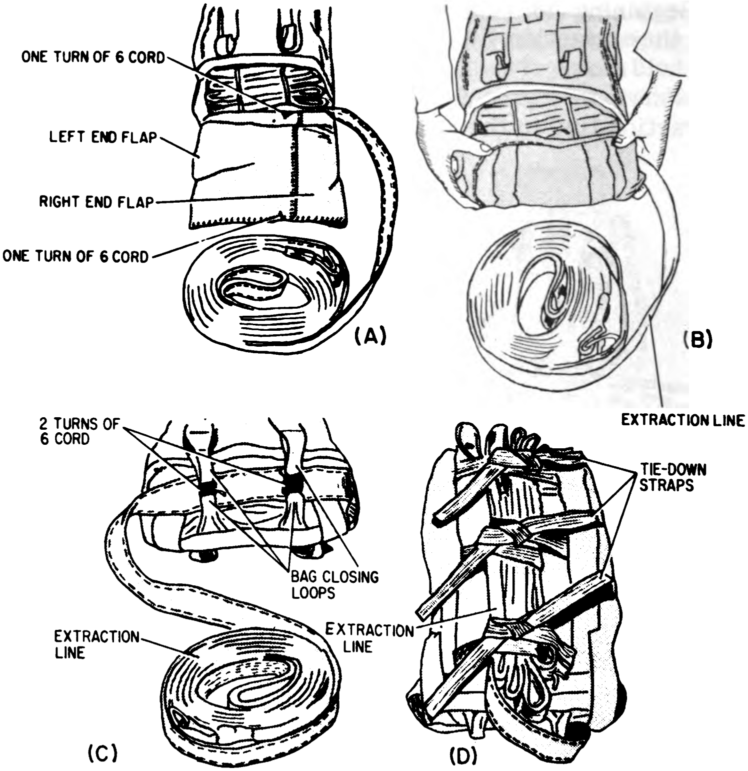


Figure 9-22.—Closing deployment bag.

This completes the packing of the extraction parachute. For temporary storage only, stow the remaining extraction line over the deployment bag and secure with the tie-down straps.

CARGO PARACHUTES

G-11 and G-11A

The G-11 and G-11A cargo parachutes are used for heavy-drop aerial delivery. The two parachutes differ only in minor details, and the procedures for handling are essentially the same.

The G-11A canopy assembly is flat, circular in shape, and is 100 feet in diameter. It is divided into 120 gores, each gore being constructed of 13 panels. The canopy has 60 suspension lines. For packing purposes, the suspension lines are considered as ending at the skirt. They are numbered from 1 to 120, counterclockwise, when facing the skirt from the connector links.

INSPECTION.—The G-11 and G-11A parachutes are visually inspected every 60 days, or more often if conditions warrant such inspection. The condition of the canopy, suspension lines, webbings, and pack should be checked for tears, excessive moisture, mildew, and stains.

LAYOUT.—A working space approximately 155 feet long is required for packing operations, provided tension is applied at the clevis loops of the riser. (See fig. 9-23.) If a packing surface of this length is not available, tension may be applied at the connector links. In this case, a surface approximately 85 feet long is sufficient. If packing tables of this length are not available, a suitable area may be prepared from a smooth section of concrete floor where the surface can be painted to eliminate the normal abrasive action of concrete. This method of packing is recommended only where packing tables are not adequate.

PACKING.—Because of the extreme large size and the limited use of the G-11 and G-11A cargo parachutes by the Navy, the packing procedures are not covered here. For the step-by-step procedure, reference should be made to the applicable maintenance and packing handbook.

HEAVY-DROP PARACHUTE RELEASE ASSEMBLIES

Jaw-Type Release Assembly

The jaw-type parachute release assembly consists of a body assembly, two release spring assemblies, two suspension slings, and two cutters.

BODY ASSEMBLY.—The steel body assembly consists of a left- and right-hand body held together by a steel shaft. The bodies are keyed to the shaft and held in place by flat washers and locking nuts, or split washers and conventional nuts. The mouth of the body assembly provides a seat for the suspension pin, and side plates cover

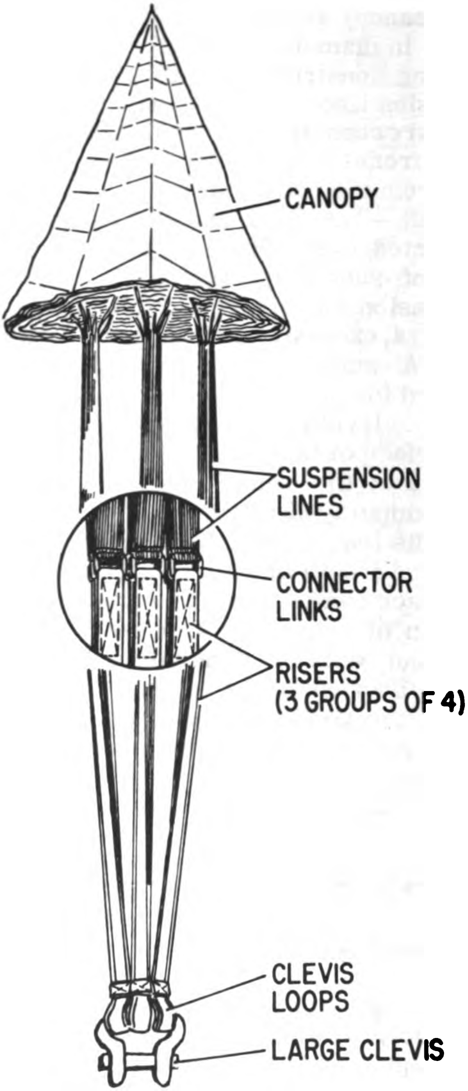


Figure 9-23.—Layout of G-11 and G-11A cargo parachute.

the open ends to prevent the suspension pin from sliding out. The jaws, which provide recesses for the cutters, are held to the lower end of the bodies by hinge pins.

RELEASE SPRING ASSEMBLIES.—Two release spring assemblies are screwed into the body assembly behind the suspension pin seat. Each assembly consists of a housing which holds the assembly, a plunger which pushes against the suspension pin, a spring which applies tension on the plunger, an adjusting screw which regulates the tension, and a cap which covers the open end of the housing. Two types of springs, lightweight and heavyweight, are issued with the release assembly. The light springs (bronze color) are used with loads requiring one 100-foot parachute; the heavy springs (silver or black color) are used with loads requiring two 100-foot parachutes.

SUSPENSION SLINGS.—Two 2-foot suspension slings are used with the release assembly. A permanent 2-foot sling is fixed at one end to the shaft of the release assembly and at the other end to the clevis assembly on the parachute risers or parachute riser extensions. The second 2-foot suspension sling is fixed at one end to the large clevis assembly on the load suspension slings and at the other end to the suspension pin which fits into the mouth of the assembly.

CUTTERS.—Two reefing-line cutters (fig. 9-24) are used with each release assembly. The cutters are inserted through the jaws and upper recesses of the body assembly and are tied in place with silk, cord, or authorized substitute material, inserted through the holes in the upper recesses and the cutters.

In operation (fig. 9-24 (B)) the firing wire is pulled out by the deploying parachute, and the firing plunger locking ball is pushed down into its recess by the firing plunger. The firing plunger, under spring tension, travels forward until the firing pin strikes the percussion cap. The cap then fires the charge through the fuse chamber, and after 10 seconds, the fuse fires the charge in the activating chamber. The activating charge then pushes the cutter blade forward, shearing the silk cord which passes through the holes on the cutter.

OPERATION.—An understanding of the operation of the release assembly will aid the Parachute Rigger in properly preparing, installing, and adjusting the

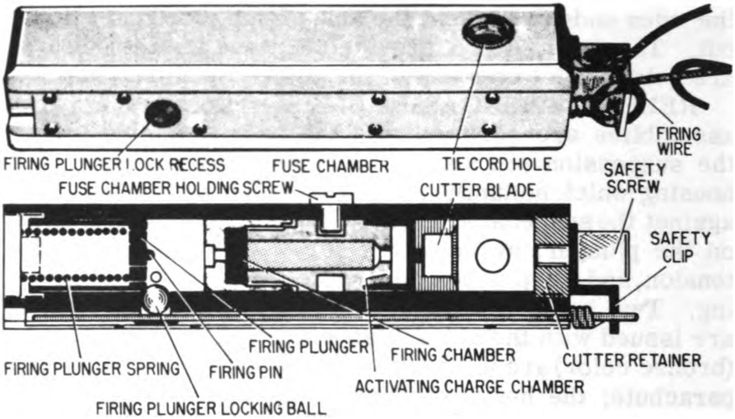


Figure 9-24.—Reefing-line cutter.

assembly. Generally, the operation of the release assembly follows the order shown in figure 9-25 (A), (B), (C), and (D).

As shown in figure 9-25 (A), when the main cargo canopy starts to deploy, it pulls on the large clevis assembly which connects the parachute risers to the permanent 2-foot sling on the release assembly. The clevis assembly, which is tied to the firing wires in the two reefing-line cutters, pulls out the wires and activates the cutters.

In the 10 seconds that elapse between the pulling of the firing wires and the firing of the cutters, the load receives the opening shock of the main cargo parachute, rebounds slightly, and settles again with its weight pulling on the suspension pin in the mouth of the release assembly.

The cutters fire and cut the suspension line that holds the cutters in the release assembly. After the cord has been cut, the cutters are free to drop out of the recesses in the top of the body assemblies, as shown in (B) of figure 9-25.

After the cutters have fallen out, the jaws pivot open, as shown in figure 9-25 (C). The suspension pin remains seated in the mouth of the release assembly as long as the weight of the load pulls on the 2-foot suspension sling, thus overcoming the tension on the release springs behind the suspension pin.

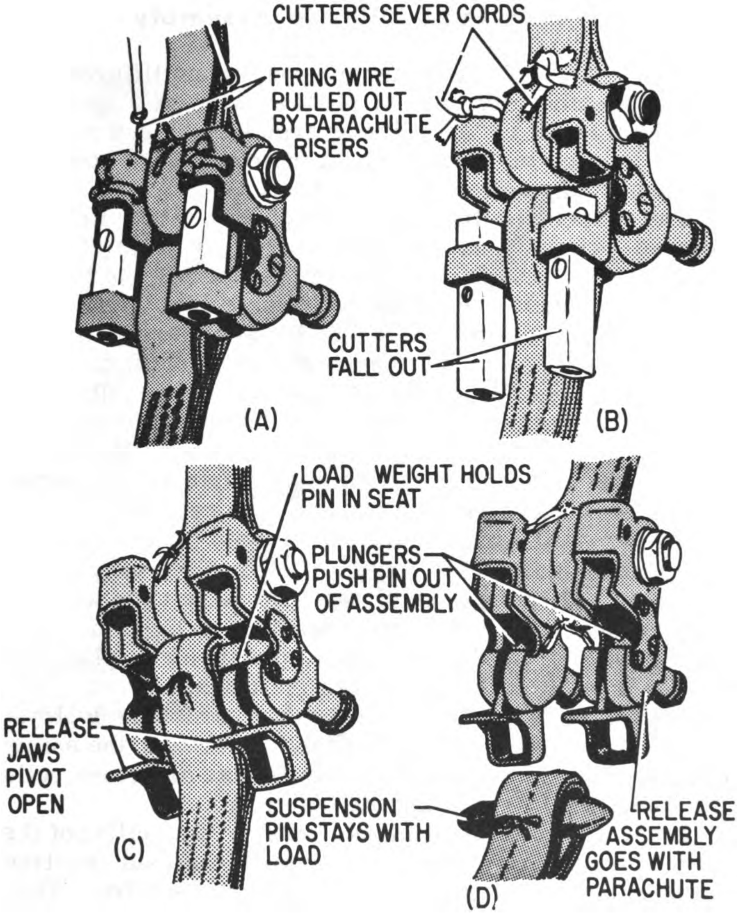

CUTTERS SEVER CORDS
FIRING WIRE PULLED OUT BY PARACHUTE RISERS
CUTTERS FALL OUT
(A)
(B)
LOAD WEIGHT HOLDS PIN IN SEAT
PLUNGERS PUSH PIN OUT OF ASSEMBLY
RELEASE JAWS PIVOT OPEN
SUSPENSION PIN STAYS WITH LOAD
RELEASE ASSEMBLY GOES WITH PARACHUTE
(C)
(D)

Figure 9-25.—Operation of release assembly.

As the load strikes the ground, the suspension pin is relieved of the weight which holds it in the assembly. The release plungers, under spring tension, push the suspension pin out of the mouth of the release assembly, as shown in (D) of figure 9-25. The load is then freed from the parachutes, preventing the parachutes from dragging or upsetting the load.

Finger-Type Release Assembly

DESCRIPTION.—The finger-type, or multifinger, release assembly consists of a steel body with two body plates, release lever, release arm link, and a release arm. Pivoted on hinge pins at the edge of the body are the large and small cutter retainers.

The suspension finger slings used with the multifinger release assembly are constructed of six plies of nylon webbing. To permit the close fitting of release fingers over the release arm of the body assembly, as shown in figure 9-26, the slings are issued in two different lengths. The fingers pivot on hinge pins on the finger links.

One reefing-line cutter is used with the multifinger release assembly. The cutter is inserted through the large and small cutter retainers of the body. The operation of the cutter is on the same principle as the operation of the cutters used on the jaw-type release.

Two types of springs may also be used with the finger-type release assembly. Lightweight or heavyweight may be used, and the weight of the load being used with the release assembly determines whether a light or heavy spring will be used and whether the spring is placed at the No. 1 or No. 2 force point of the release lever.

OPERATION.—As the main cargo parachute deploys, the riser extension of one parachute breaks the safety cord holding the riser link to the release arm, then pulls the firing wire out of the time cutter.

In the 10 seconds that elapse between the pulling of the firing wire and the firing of the cutter, the load receives the opening shock of the main cargo parachutes. Then the load rebounds slightly, and settles again with its weight pulling against the release arm link, holding the link stud in the body plates.

The cutter fires and cuts the suspension line casing that holds the cutter in the retainers. After the line has been cut, the cutter is forced out of the small cutter retainer by the cutter ejecting spring and rotates in the lower cutting retainer.

After the cutter has fallen out, the release arm link is free to pivot outward, but as long as the weight of the load pulls against the assembly, the link stud will be held in the notch in the body plate.

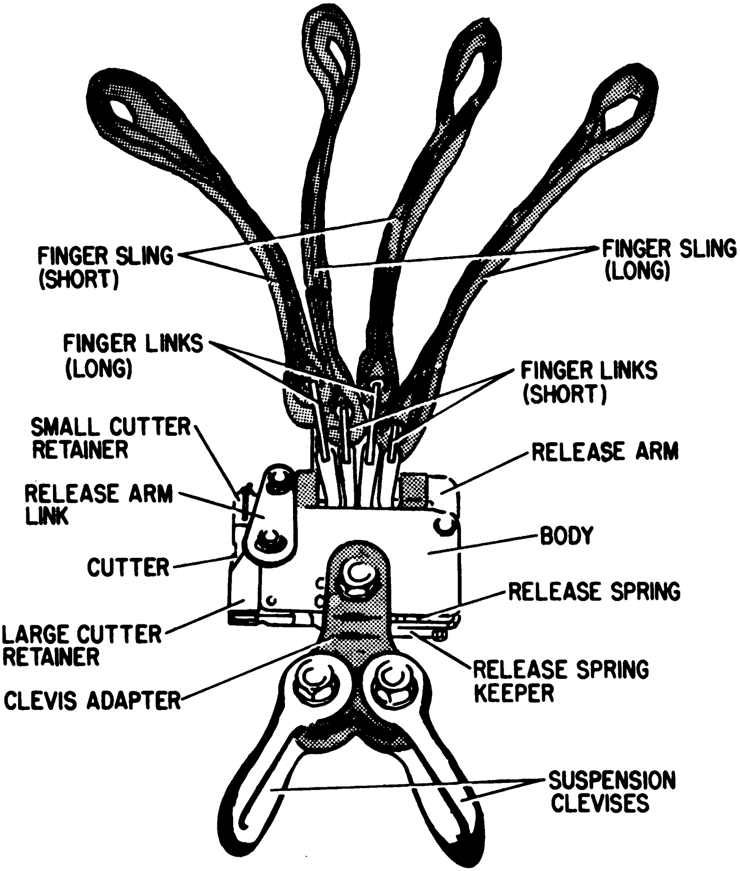


Figure 9-26.—Finger-type (multifinger) release assembly.

As the load strikes the ground, the release arm link is relieved of the weight which holds it in the assembly. The release lever, under spring tension between the body plates, is thus able to pivot upward, pushing the link stud out of the notch in the body plates.

The drag of the parachutes then pulls the release arm upward (fig. 9-27) until the fingers, which are hooked around the release arm, clear the slot that holds the fingers closed between the body plates. As soon as the fingers are clear, they spread open, freeing each parachute separately from the load, thus preventing the parachutes from dragging or upsetting the load.

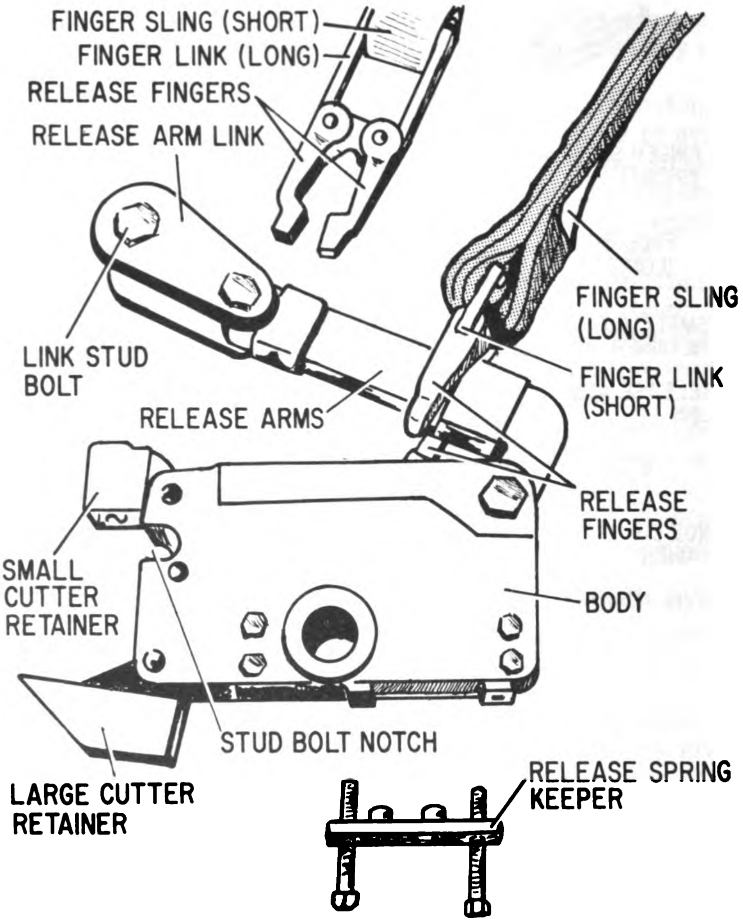


Figure 9-27.—Operation of finger-type release assembly.

QUIZ

1. The diameter of the G-1 and G-1A cargo parachute canopy is_______feet.
    - a. 20
    - b. 24
    - c. 28
    - d. 30

2. The number of gores in a G-1 or G-1A cargo parachute canopy is
    - a. 20
    - b. 24
    - c. 28
    - d. 30
3. The difference in length and width of the patch and the damaged area of a cargo parachute canopy is
    - a. 2 inches wider; 3 inches longer
    - b. 1 inch longer; 2 inches wider
    - c. 3 inches longer; 3 inches wider
    - d. 3 inches longer; 2 inches wider

4. The pack of the G-1 cargo parachute has
    - a. 1 part
    - b. 2 parts
    - c. 5 parts
    - d. 3 parts
5. The length of the static line used with the G-1A cargo parachute is
    - a. 15 feet 4 inches
    - b. 16 feet 4 inches
    - c. 15 feet 3 inches
    - d. 16 feet 3 inches

6. The maximum load for the type A-4 cargo container is_______ pounds.
    - a. 100
    - b. 150
    - c. 300
    - d. 200
7. The type A-5 cargo container is used for dropping
    - a. three 5-gallon cans
    - b. boxes
    - c. 20-mm ammunition
    - d. M-1 rifles

8. The two webbing sling containers are
    - a. A-7 and A-9
    - b. A-5 and A-6
    - c. A-7 and A-10
    - d. A-9 and A-10

9. The type A-10 cargo container is a
   a. webbing sling
   b. corrugated fiber carton
   c. cargo net
   d. rigid, octagon-shaped container

10. The minimum altitude for dropping an aerial delivery container is _______ feet.
   a. 200
   b. 300
   c. 400
   d. 500

11. The maximum speed for dropping an aerial delivery container is _______ m.p.h.
   a. 100
   b. 150
   c. 200
   d. 85

12. The length of the static line used with the A-7 and A-10 cargo containers when dropped from external bomb racks is _______ feet.
   a. 15
   b. 12
   c. 10
   d. 6

13. The diameter of the extraction parachute is ________ feet.
   a. 15
   b. 20
   c. 24
   d. 28

14. The diameter of the G-11A cargo parachute is ______ feet.
   a. 30
   b. 80
   c. 100
   d. 150

15. The number of gores in a G-11 cargo parachute is
   a. 60
   b. 160
   c. 120
   d. 80

16. The G-11 and G-11A cargo parachutes are inspected every
   a. 30 days
   b. 60 days
   c. 90 days
   d. 6 months

17. The approximate space required for packing the G-11A cargo parachute is_______feet.
    a. 80
    b. 100
    c. 145
    d. 155
18. The two types of release assemblies used with heavy drop parachutes are
    a. finger and claw types
    b. claw and jaw types
    c. finger and cutter types
    d. jaw and finger types
19. The bronze colored spring is used with the release spring assemblies when using loads requiring
    a. two 100-foot parachutes
    b. three 100-foot parachutes
    c. one 100-foot parachute
    d. two 50-foot parachutes
20. The delay between the pulling of the firing wire and the firing of the cutter is _______seconds.
    a. 3
    b. 5
    c. 8
    d. 10

CHAPTER 10

PRESSURE SUITS AND MISCELLANEOUS PERSONAL EQUIPMENT

In setting out to solve the problems of man's survival in high altitude flight or, what can, from an environmental physiological sense, be called the fringe of space, the resources of several fields of science, namely, astronomy, medicine, and engineering have had to be pooled. Each of these sciences looks upon the conditions that exist from the surface of our earth outward with different concepts. An altitude of 100,000 feet to the astronomer is infinitesimal, for he thinks in terms of light years. To the engineer, altitude is thought of in terms of the physical forces that would affect the equipment with which he is working. To the biological scientist, his main consideration is what effect this new environment will have on a biological system, thus aviation medicine considers the effects on man's biological systems which are introduced by ascending to higher and higher altitudes, and from his point of view the fringes of space start at about 50,000 feet.

Man's body is designed to function in the airy environment of the atmosphere which furnishes an ever-ready supply of breathing oxygen. Yet, this is not the only benefit that man derives from the sea of air in which he lives. By an exchange of heat between day and night, or summer and winter, the atmosphere maintains a well balanced temperature level. The air transmits only the beneficial portion of the sun's radiation, while it absorbs the harmful ultraviolet rays. We spend our lives on the surface of the earth, at the bottom of a sea of air which envelops the entire planet. The atmosphere forms our environment. If we ascend higher and higher into the upper layers of the atmosphere, we gradually transform our normal habitat into the environment of space, at least from a biological sense. At increasing heights above the surface of the earth, the density of the air decreases rapidly and we are deprived, one after the other, of all the life-sustaining elements which the atmosphere so abundantly supplies.

The biologist studies the behavior of living beings; in the case of aviation medicine he studies the reaction of man to this new environment. We expect the flight surgeon to have a much different opinion of the borders of space from that of the geophysicist, astronomer, or engineer. The flight surgeon identifies these borders with the line where the environment of space begins.

To the living being, the incomprehensibly thin remains of the atmosphere at 600 miles of height is useless. For all practical biological purposes there is no response by any living organism to this kind of air. Biologically, the borders of space lie much closer to the earth. The interrelations between man and the air are so complex and ramified that we cannot expect all facets of the environment of space to appear simultaneously at a single critical level but will be at a stratified set of levels, one for each particular element of the functional relationship between man and the air ground.

The peak of Mt. Everest, in the Himalayas, is the highest point on earth. Its lofty height was finally conquered after many unsuccessful attempts. Aircraft have flown over its snowy flanks and pilots have looked down on its summit, but only after 50 years of assault has man trod on its top, the top of the world. The icy air that blows about its 29,000-foot summit in almost everlasting gales is so thin that mountaineers were stopped by want of oxygen rather than by cold, ice, and monumental cliffs. At these heights the human organism approaches a natural environmental limit.

If the air becomes too thin, the atmosphere can no longer meet the most elementary demands of the organism, namely, a steady supply of breathing oxygen. To supply us with an uninterrupted stream of this vital gas that powers the process of life is the most important function of the atmosphere.

Because of man's complete dependence on atmospheric oxygen, it is by no means amazing that the atmosphere fails to support our respiratory needs at a comparatively low altitude. One can adapt oneself to decreased oxygen pressures which exist at levels as high as 25,000 to 30,000 feet by gradually moving to successively higher levels. But this requires spending several weeks or even months at 15,000 to 20,000 feet. People living in the mountains have more red blood cells than do people who spend their lives near sea level. Other physiological mechanisms, such as increased rate and depth of breathing, help to overcome the shortage of oxygen in the rarefied air of the mountains. Naturally, there is a limit to the extent to which human organisms can adapt, and eventually we must reach the functional border of space, so far as the respiration is concerned.

The normal chemical form of oxygen, which has two atoms of oxygen per molecule, is the only kind of oxygen the human organism can use. At an altitude of 60 to 70 miles, diatomic oxygen vanishes from the air and gives way to atomic oxygen, which is the only chemical form of this element in the upper strata of the atmospheres. There are two ozone layers. The surrounding atmosphere is composed of diatomic oxygen and other gases. The ozone layers are at 60,000 to 80,000 feet and at 160,000 feet. The normal oxygen molecule cannot exist in these high layers. Some ultraviolet radiation from the sun, which never reaches the earth's surface, severs the oxygen molecule into its two component atoms. It would appear from this that the functional limits of respiration lie at these levels where molecular oxygen vanishes from the air. One would conclude that the rarefied oxygen could still contribute to man's respiratory needs, though insufficiently. Yet, it is not the case. At an elevation of about 10 miles, less than twice the height of Mt. Everest, the mechanism of respiration begins to fail; the surrounding air can no longer be drawn into the lungs. The oxygen present is of no further use to the body's demands. So one sees that the respiratory border of space is very close to the surface of the earth.

The failure of respiration at altitude is demonstrated by modern aviation in the most dramatic fashion. Airmen have long been beset by the scarcity of oxygen aloft; yet, until a decade ago fliers could be protected against the lack of breathable air by relatively simple means. The oxygen equipment used by aviators during the war consisted of a breathing mask and hose which fed enriched or pure oxygen into the mouth and nose. Since that time, there have been many refinements on the mask and the regulation of the amount and percentage of oxygen delivered to the mask. The diluter demand regulator served to conserve the oxygen supply that the plane could carry by so regulating the flow to the mask to give the proper oxygen concentration for the corresponding altitude.

The regulator was further refined to accommodate the pilot flying above 35,000 feet. In this case the oxygen must be delivered under pressure, for the barometric pressure above 35,000 feet is insufficient. Even 100 percent oxygen, when thinned out by the drastically reduced pressure at these heights, cannot prevent a serious deficiency of this vital gas to the lungs. The pressure breathing mask and regulator has several limitations and may be considered only an emergency interim piece of equipment, for by the time an altitude of 45,000 feet is attained, 100 percent oxygen must be delivered from the regulator through the mask to the lungs at a pressure of about 12 inches of water. This makes breathing difficult and cannot be tolerated for any length of time. If the pressure by which 100 percent oxygen is delivered to the lungs was increased, we would run the risk of damaging the lungs themselves.

There is only one way of giving the pilot what he needs, and that is to pack more oxygen into each breath if it is given in a more concentrated form. In other words, the flier must breathe his oxygen at a much higher pressure than is found above the critical altitude. The partial answer is the pressurized cabin. All modern military aircraft are equipped with pressure cabins. The thin ambient air is compressed and admitted into the cabin, while a controlled escape valve serves to maintain the desired pressure level.

There is no doubt that pressurized aircraft is a partial solution to the oxygen problem encountered at high altitude, but pressurized cabins have limiting factors imposed upon them. The higher we go the more rarefied the air. This means the compressing pumps used to pressurize the cabins must be larger and more efficient and, of course, require more power. This, in turn, places a weight factor limitation. Also, the heat generated in the process of compressing the rarefied air becomes an additional problem, and, of course, if we get high enough there just isn't enough air available to even compress.

Even more striking is the fact that there is only a thin wall standing between the pilot and the thin air outside. The pressurized aircraft is a precarious device, for a sudden breakage of the cabin shell is a major disaster. The precious cabin air is rapidly lost in a more or less violent outbreak. The occupant suffers what is termed explosive decompression. This opened a new phase of respiratory aviation medicine.

Volunteer subjects were seated in a small chamber and taken to a simulated altitude of 10,000 to 20,000 feet. This small chamber was connected to a much larger chamber that was evacuated to a simulated altitude of 40,000 to 50,000 feet or higher. The lock between the two chambers was closed by a thin but strong membrane that separated the two columns of air. In front of the lock, a sharp edge was mounted on a level. At a signal the edge fell, rupturing the membrane, and the air in the small chamber rushed out and escaped into the comparative emptiness of the large chamber. In this way the test subjects were transposed to a sharply reduced air pressure within a fraction of a second. Figuratively, the men were shot up 20,000 feet or more within a split second. The air inside their lungs was no longer restrained; it expanded violently and escaped through the windpipe like a jet of air from an open tire valve. Although the experience of being rapidly decompressed was by no means a pleasant affair, it was not a serious hazard to life or health. Even the eardrums, which would be expected to be especially sensitive to sudden pressure changes, suffered no damage. The shock experienced in no way impaired their ability to act and carry on with whatever was required of them after the explosion. However, unless the supply of breathing oxygen was restored within a relatively short time, the drastic lack of oxygen and pressure would soon have become fatal. If one suffers explosive decompression at an altitude of 25,000 feet, he loses consciousness after about five minutes. This critical time span is the TIME OF USEFUL CONSCIOUSNESS.

When cabin pressure is lost due to explosive decompression, the time of useful consciousness assumes its true, grim meaning. The valuable time reserve, which is left before unconsciousness making the pilot helpless, becomes smaller and smaller as the altitude increases. It is about 1.5 minutes at a height of 30,000 feet, and less than a minute at 40,000 feet. At 50,000 feet, however, the time of useful consciousness drops to about 11 to 18 seconds. At an altitude of 50,000 feet, roughly 10 miles, we reach the functional borders of space, so far as respiration is concerned.

A man's fate would be the same whether he encountered explosive decompression at 10 miles, 50 miles, or on the moon. He would fall unconscious in about 15 seconds and die soon afterward. An altitude of 10 miles is amazingly low, for we think nothing of a 10-mile travel on the surface of the earth. It is true that air found at critical altitude still contains molecular oxygen that can be used for breathing. In fact, air at sea level pressure is only 9 times richer in oxygen than that found at 50,000 feet. Actually the men inside a pressurized cabin are supplied from ambient oxygen compressed to a sufficient pressure. It is thus man's physiological makeup that sets this limit. His body is not designed to benefit from oxygen if it is diluted below a critical density.

Failure of respiration at higher altitudes is caused by the chemical constitution of air inside the lungs. The process of breathing is not a one-sided transaction. The human body takes in oxygen from the atmosphere, but it also releases a stream of exhalations into the air with each breath. Carbon dioxide is waste material that results from the chemical activity of life processes. Carbon dioxide and water vapor are continuously discharged by the body. Water vapor simply evaporates from the body fluids exposed to the volume of air inside the lungs.

The existence of carbon dioxide in exhaled air can be demonstrated by laboratory means, but the water vapor of exhaled air is a matter of common experience. On a cold day the exhaled water vapor is readily visible as a cloud of fog, condensing from the mouth. Carbon dioxide and water vapor account for about 11 percent of the entire mixture in the lungs. Their combined pressure in the chest is much higher than it is in the air which we inhale. In air, the amount of carbon dioxide is negligible, and water vapor rarely provides more than 2 percent of the entire air at atmospheric pressure. We carry large amounts of these two components in our lungs because they are steadily produced on the surface of the lung tissue where they stream profusely from the blood.

The pressure of the air in the lungs is always equal to the barometric pressure of the surrounding air. At higher altitudes, where the atmospheric pressure is lowered, the air in the chest suffers an equal loss of pressure. However, the combined pressure of carbon dioxide and water vapor does not change, because they are steadily stocked up by the circulation of the blood. If air is breathed of progressively small density, carbon dioxide and water vapor claim an ever increasing percentage of the air we carry in our lungs. As soon as the atmospheric pressure drops to 11 percent of the sea level value, the entire volume of the lungs is occupied exclusively by the gaseous waste products of the blood. This critical point is reached about 50,000 feet above the ground. Inhaling and exhaling become vain acts at this height. If the chest is expanded in an attempt to inhale, it merely causes the blood to yield more carbon dioxide and that fills the entire additional space. By attempting to exhale, it compresses the volume of waste gases in the lungs and forces it back into the blood. At an altitude of about 10 miles, breathing degenerates into a useless cycle in which carbon dioxide and water vapor are pumped back and forth from the blood to the lungs and back again to the blood.

The process of effective respiration comes to an end. The surrounding air does not even enter the chest when the motions of breathing are gone through at this altitude and above. Therefore, it does not matter whether the air around contains oxygen or not. It does not even matter if there is no air at all. If the barometric pressure falls below 11 percent of its normal value on the ground, the air around might just as well not exist, as far as the breathing process is concerned. This altitude is the environment of interplanetary space.

If an aircraft cruising at 30,000 feet loses its cabin pressure, the pilot can save himself by putting on an oxygen mask within the minute following the explosive decompression. At that height the ambient pressure is still great enough to get sufficient oxygen into the pilot's lungs with each breath. Above 50,000 feet however, the oxygen mask is of no further use. Man suddenly exposed to barometric pressure above the critical altitude is on his pitiful own; he has only the oxygen accumulated in his blood and tissues during the time prior to explosive decompression (which would be approximately 15 seconds). The highly specialized tissue of the brain consumes much oxygen, and it takes only 15 seconds for the oxygen in the brain cells to fall short of the continuous great demand, causing loss of consciousness.

On passing the 50,000-foot mark, man is admitted into the domain of space, where the thin remains of atmosphere cease to support him in his most vital need, a steady, uninterrupted stream of oxygen to be kept flowing through every cell of his body. Without this invisible, odorless, tasteless and intangible element of life, man is doomed within an incredibly short span of time. In many instances, manned aircraft have passed this border and made quick dashes through the realm of space, but for this kind of venture, the pilot must be specially equipped. One type of special equipment is the full pressure suit.

Above 63,000 feet there is still another barrier for human life to face, because at this altitude, atmospheric pressure drops so low that it can no longer prevent boiling of the blood and other fluids in the body. If boiling occurs, serious disturbances and possibly irreparable damage must be anticipated.

There are two ways in which a liquid can be caused to boil. One way is to heat the liquid until its temperature reaches the so-called boiling point. The other method is to lower the barometric pressure, which lowers the temperature that will cause boiling. The human body and blood have a temperature of 98.6° F. Therefore, the blood and body fluids will start to boil at an altitude where the barometric pressure of the air has dropped to a point that will allow blood and body fluids to vaporize at a temperature of 98.6° F. This critical mark is 63,000 feet above the surface of the earth, where barometric pressure is less than 1 p.s.i. The boiling of body fluids at an altitude of about 12 miles marks a further functional border of space. Beyond this border, the protection of an individual against loss of artificial pressure becomes a vital necessity, lest he suffers a quick, blood-boiling death.

Basically, this leaves us with the fact that men flying modern high-altitude aircraft and aircraft of the near future will require a pressure cabin and, in conjunction with this, an individualized pressure garment, to be able to safely penetrate biological space.

This individualized pressure garment must be comfortable, mobile, and be able to take over immediately if cabin pressure is lost. It must offer protection from the effects of explosive decompression, wind blast, and cold, and give complete protection from the hazards of low barometric pressures and extremely low oxygen tension. It should also be as automatic as possible and be able to operate under all conditions. It should also be capable of protection in case of bailout.

This is exactly what the Mk IV full pressure suit will do, and through a detailed description of its operation, by demonstration in the fleet, and by actual use of the suit, it is felt that the suit will prove its effectiveness beyond a doubt.

MK IV FULL PRESSURE SUIT

The Mk IV full pressure suit is a close fitting, continuous wear garment that provides the pilot protection against the effects of low ambient pressures, explosive decompression, and land and water exposure.

The description, construction, and sizing of the Mk IV full pressure suit, the construction and operation of the Mk II suit controller, and general information on the integration of the suit system with the aircraft is discussed in the following pages. Figure 10-1 is a front view of the complete suit assembly.

The full pressure suit consists of four components—the torso, helmet, gloves, and boots. (See fig. 10-2.)

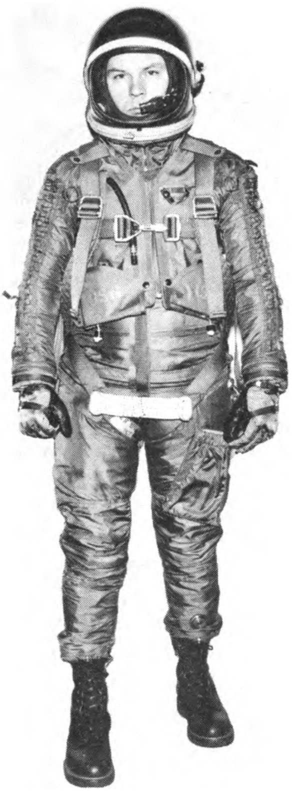


Figure 10-1.—Mk IV full pressure suit.

The suit is a flexible pressure-tight garment intended for wear by flight personnel at altitudes above 45,000 feet in order to protect them from the effects of low ambient pressures and of explosive, rapid, or slow decompression. It is also intended to protect the wearer from exposure to extreme ambient and water temperatures, as a result of emergency ditching of an aircraft.

The suit torso is tailored to be a closely fitted coverall-type garment encompassing all of the body with exception of the head and hands. A neck ring is the attachment point of the helmet and also acts as the pivot for the head and neck. Within the helmet is incorporated the breathing regulator and communication system. The gloves extend from the lower one-third of the forearm to the fingertips, and when attached to the sleeve of the torso, form a continuous assembly. The boots extend over the upper one-third of the lower leg to the bottom of the foot and, when worn, form a continuous assembly.

Accessory suit equipment consists of an integrated flotation garment with parachute harness and waffle weave underwear for use in cold climates. An anti-g suit is worn when operational requirements warrant its use. Accessories are shown in figure 10-3.

Under normal conditions, with the cockpit adequately pressurized, the pressure suit remains in an unpressurized state; and any pressurization that occurs is due to high ventilation flows. The ventilation air is supplied

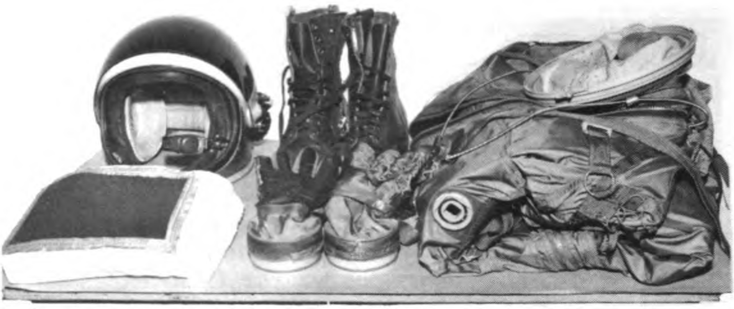


Figure 10-2.–Basic components.

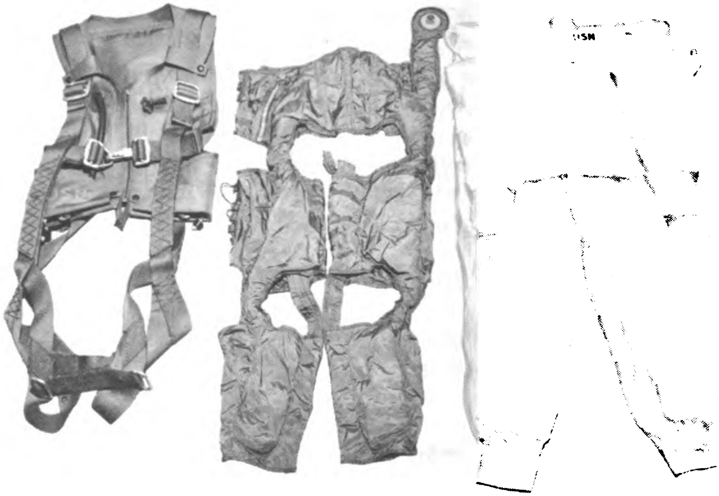


Figure 10-3.–Full pressure suit accessories.

from the plane's air-conditioning system, monitored through the pilot's manual control valve, and channeled by way of a disconnect into "Trilok ducting" which is an integral part of the torso. This air flows through the ducting and exists at the wrists, ankles, crotch, and periphery of the neck ring. It then flows into the body of the suit so as to remove excess moisture from the body. The air leaves the suit exhaust port and is expelled through the relief port of the suit controller into the cockpit. In addition to ventilating the suit, this air also pressurizes it when required.

The full pressure suit system is designed to respond to and function under several distinct conditions that might be encountered in flight.

1. In normal flight with adequate cabin pressurization, the suit is pressurized only to a very slight extent due to the ventilation airflow.

2. When ambient absolute pressure falls below 3.4 p.s.i. (atmospheric pressure at 35,000 feet), the suit will immediately become pressurized by ventilation air.

3. If the ventilation air is lost, the aircraft oxygen supply will pressurize the suit as well as supply breathing oxygen.

4. In the event of bailout, the emergency oxygen supply will pressurize the suit as well as supply breathing oxygen.

The design of this oxygen breathing system is unique in that there is never any need for pressure breathing. While wearing the full pressure suit, one never has to resort to pressure breathing above a slight one inch of water pressure.

The freedom afforded by this system of not having a mask tightly cinched across the face and covering the nose and mouth is also an additional pleasant advantage.

Suit Components

SUIT TORSO.—The suit torso is basically a two-layered garment. It is constructed of an inner airtight layer made of cured neoprene coated fabric and coated Helenca fabric in the stretch areas, with the seams in the inner layer cold cemented. A sage green nylon fabric coverall serves as an outer garment. Entrance to the suit is accomplished by means of a pressure sealing zipper located on a diagonal across the frontal torso section, extending over and terminating approximately 3 inches below and posterior to the shoulder cap. A safety relief valve which relieves at 4.0 ± 0.5 p.s.i. is provided for use in the event of overpressurization of the suit system.

NECK SECTION.—The inner layer of the neck section is made of neoprene coated Helenca Knit fabric. The outer restraint fabric has a reduced neck circumference and incorporates one centrally located front neck zipper, resembling an hour glass configuration. A neck ring bearing assembly with an internal diameter of 8-1/2 inches is attached to the neck section.

SHOULDER, ARM, AND LEG SECTION.—The shoulders, upper arm, and wrist sections are without bearings. Provision for shoulder and arm mobility is arranged by means of Helenca knit stretch fabric tailored into the inner layer of the suit in the shoulder, arm, and crotch section of the torso. In addition, the arm and leg are intimately tailored to reduce bulk with the outer ply of these sections having a pleated-type construction to facilitate mobility in these areas. The outer ply of these sections also accommodates a nylon adjustment strap for sizing (fig. 10-4). These straps are channeled along the sides of the arms and legs and are patterned to give a reasonable fit from the 5th to the 95th percentile range of pilot population. Sock-type endings for the legs are made of nylon Helenca fabric, have a thin ply of neoprene gum applied, and are permanently attached to the inner layer of the suit. "Iron Age" boots are provided for wear and restraint.

HELMET AND WAIST SUSPENSION TIEDOWN.—The helmet holddown system consists of cable, grommet, and pulley arrangements. This system prevents headpiece rise under maximum suit pressure and permits side-to-side nodding at suit pressures up to 1.5 p.s.i. The waist suspension system includes a midsection and two side tiedowns and provides the suit with a "sit-stand" feature. To stand from a sitting position requires a release of the midsection tiedown buckle, thus releasing the webbing restraint and permitting elongation of the torso. To return to the seated position requires tightening of the midsection webbing.

SUIT SERVICE CONNECTIONS.—There are four suit port fittings located in the upper torso below the left and right armpits—the anti-g suit fitting, located in the left front; ventilation garment fitting in the left rear; the suit exhaust in the right front; and the pressure sensing line, located in the right rear. Associated hose nozzles with positive lock-type fittings mate with the port fittings. It is anticipated that the later model of the Mark IV full

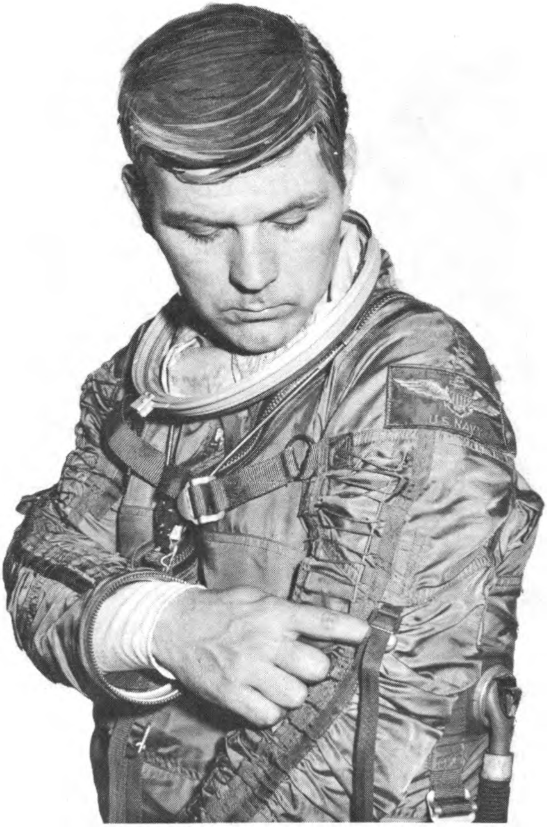


Figure 10-4.—Nylon adjustment strap for sizing.

pressure suit will be equipped with a direct reading altimeter located on the frontal thigh of the left leg. In these suits, the indicator port will come equipped with a removable plug. This port, although not required during flight, is needed for use during sea level testing in conjunction with the pressurization control test kit.

INTEGRAL VENT SYSTEM.—The integral vent system, which distributes the flow of ventilation air, consists of a manifold plenum chamber with six outlets. Tubes of fabric and Trilok distribute the air efficiently to the wrists, ankles, crotch, and neck areas. A suitable check valve, which maintains the integrity of the suit in the event of vent hose separation, is incorporated within the inlet port fitting. Figure 10-5 is an internal view of the torso, showing inner layer construction and the suit vent system.

SUIT SIZES AND SIZING.—The basic suit components are fitted to a particular individual by a selection of properly sized components and, in the case of the suit torso, by means of adjustable features of the suit.

The suit torsos are supplied in twelve stock sizes, six basic chest sizes, patterned with either a short or long vertical trunk size. (See table 10-1.) These stock sizes are based on a relationship between the individual's expanded chest circumference and vertical trunk circumference only. Suit fitting of an individual is accomplished by selection of a stock size suit most comparable to the individual's expanded chest and vertical trunk dimensions. "Functional" fitting is attained by the use of the length adjustment straps and circumferential lacing adjustments, as required. For maximum operational suitability, a functional fit is a necessity.

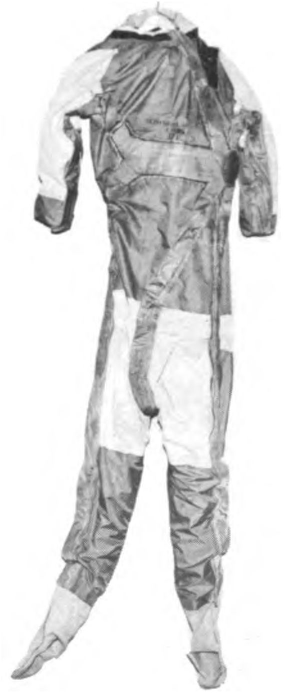


Figure 10-5.—Internal view of torso, showing inner layer construction and suit vent system.

HELMET.—The helmet (fig. 10-6) is constructed from phenolic resins and fiberglas cloth and is designed to provide for maximum visibility, comfort, mobility, windblast protection, crash protection, ease of donning, removal, and simplicity of operation. It is provided with a head suspension system, an AIC-10 communication system, and a face seal that prevents leakage in either direction; i.e., air or oxygen. An exhaust check valve permits the exhaled gas to pass from the respiratory section into the torso section. The oxygen regulator is a demand type that delivers at a positive pressure 100 percent oxygen, and can be turned ON and OFF manually.

Table 10-1.—Schedule of stock suit sizes.

Mk IV Pressure Suit Size	Pilot Physical Dimensions (inches)	
	Expanded Chest Dimension	Vertical Trunk Circumference (Standing)
Small - Short	To 37.25	To 62.5
Small - Long		62.5 - Up
Small-Med-Short	37.25 to 38.87	To 63.0
Small-Med-Long		63.0 - Up
Medium - Short	38.87 to 40.75	To 64.0
Medium - Long		64.0 - Up
Med-Large-Short	40.75 to 42.00	To 65.0
Med-Large-Long		65.0 - Up
Large - Short	42.00 to 43.50	To 65.5
Large - Long		65.5 - Up
Ex-Large-Short	43.50 Up	To 66.0
Ex-Large-Long		66.0 - Up

The ON-OFF button on the model GR-90 regulator automatically deflates the visor seal when in OFF position, enabling the wearer to open the visor after inhaling to bleed off pressure.

VISOR.—The lens configuration is made of Plex II Plexiglas and permits the wearer to see to the full extent without optical distortion. It is retractable; and when in a closed position with oxygen ON, maintains its integrity by means of a pneumatic seal that locks the visor in a leaktight closed position. A retractable tinted plastic lens, which affords approximately 17 percent light transmission, is also provided for sun glare protection, and

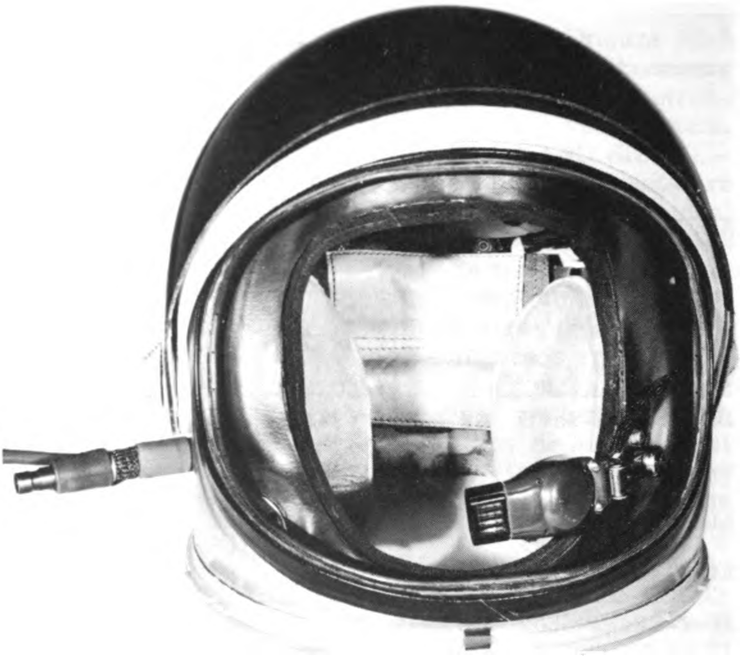


Figure 10-6.—Helmet.

trunnion knobs are provided on either side of the visor for actuation of the clear or tinted visor.

FACE SEAL AND ADJUSTMENTS.—The face seal separates the respiratory section from the suit section. The wide soft rubber seal is cemented to a soft aluminum frame which can be bent to conform to the symmetry of the face. A knob on the right exterior of the headpiece is used to effect a tight face seal by means of an internal worm gear assembly.

COMMUNICATIONS.—The earphones mounted inside the headpiece are the full comfort type and can be adjusted up or down. A boom-type (AIC-10) microphone is mounted on the aluminum face seal frame. The lead wires for the communication system are molded into the oxygen delivery hose on the helmet.

OXYGEN REGULATOR.—A Firewel GR-90 positive pressure, demand oxygen regulator is attached to the headpiece and delivers breathing oxygen to the respiratory section under a positive pressure of 1.0 to 1.5 inches of water. This positive pressure is provided to prevent any ventilation air leaking from the suit through the face seal and thereby diluting the breathing oxygen in the respiratory section.

The oxygen flows into the headpiece to the area between the face seal and the visor. It enters this area through a perforated tube surrounding the visor area and flows across the visor so that it serves the dual purpose of supplying breathing oxygen and also a supplemental means of defogging the visor. The holes in the delivery tube are larger on the downstream end, allowing an even flow of oxygen to wash across the visor.

EXHALATION VALVE.—Exhaled air passes out of the headpiece through an exhaust valve into the body of the suit. The exhalation valve is made of aluminum and cemented into the diaphragm near the chin level. The valve is spring loaded to one inch of water pressure and has a mica disc seat. The pressure-compensated exhalation valve is designed to maintain the positive pressure supplied to the respiratory section.

NECK BEARING.—To enable the pilot freedom of head movement in both the ventilated and pressurized state, a neck bearing is provided in the neck section. This bearing consists of alternating nylon and steel balls that rotate in an inner and outer race. A Teflon seal supplemented by a rubber quadrant O-ring seal give the bearing its airtight and watertight characteristics.

GLOVES.—The gloves provided for the pressure suit are constructed of the same material as the body of the suit and have leather-covered palms for greater wear. A palm restraining wire is bent to fit the hands in order to prevent the palm of the gloves from ballooning when pressurized. Gloves are patterned in 13 sizes and furnished in four palm sizes of small, medium, large, and extra large, with each palm size available in short, regular, and long finger sizes. On the Mk IV suit the gloves are attached by means of a male and female disconnect that contains an O-ring seal to prevent leakage. The gloves are secured by a slide fastener zipper.

BOOTS.—The leather "Iron Age" boots are worn over the air retaining boot sections and are modified to incorporate a zipper for simplicity and ease of donning and doffing.

SUIT CONTROLLER

If any one item of the pressure suit equipment could be considered the most important in the system, the suit controller is that item. The suit controller (fig. 10-7) is the heart of the suit pressurization system.

Construction of Suit Controller

The suit controller is made of cast aluminum and contains the following six compartments: suit, water check valve, suit control, suit demand, aneroid, and demand valve control.

The exhaust air control compartment is located in the top portion, as shown in figure 10-8. A silicone diaphragm divides the compartment into two sections. The oxygen side of the diaphragm is the CONTROL section; the exhaust air side is the CONTROLLED section. The diaphragm acts over a peripheral opening in the controlled section to monitor exhaust air from the suit to the atmosphere. Oxygen is ported to the control section from the aneroid compartment.

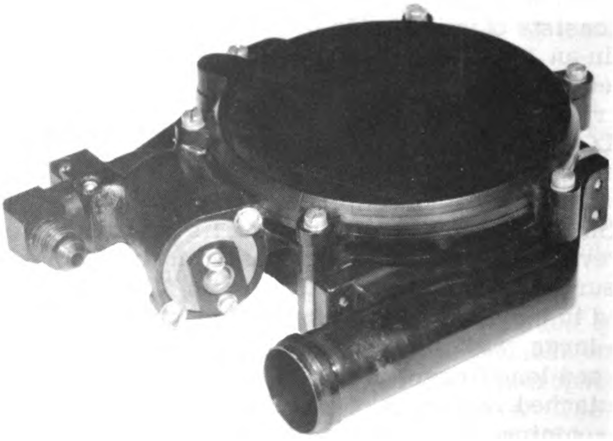


Figure 10-7.—Full pressure suit controller.

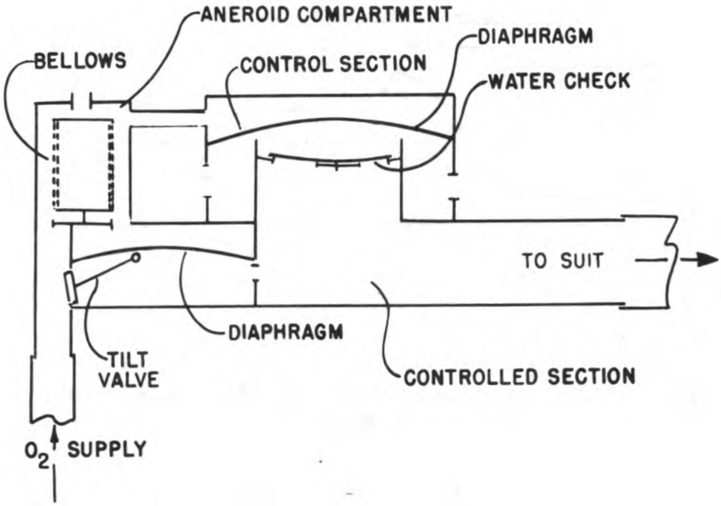


Figure 10-8.–Schematic diagram of suit controller.

The oxygen demand compartment controls the oxygen delivered to the pressure suit when oxygen is needed. A silicone diaphragm divides this compartment into two sections. One section is ported to the aneroid compartment. The second section houses a tilt valve and is ported to the exhaust air controlled section. The downward motion of the diaphragm dividing these two sections actuates the tilt valve to supply oxygen to the suit when needed.

The aneroid compartment houses a bellows which, by its expansion or contraction, monitors the oxygen bleed from the controller by opening or closing a port from the aneroid compartment to the atmosphere.

Operation

The suit controller automatically performs a multitude of duties. It controls the pressure in the suit by regulating the exhausting of gases from the suit and/or by controlling the flow of oxygen to the suit. At any altitude above 35,000 feet, the suit controller holds a differential pressure in the suit to maintain a constant altitude of 35,000 feet.

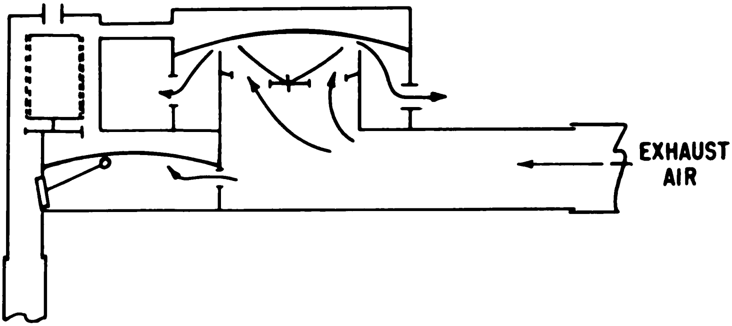


Figure 10-9.—Schematic diagram of suit controller, passing ventilation air only.

VENTILATION ONLY.—Figure 10-9 is a schematic diagram of the suit controller with ventilation air passing through the unit. Ventilation air, which is supplied by the compressor section of the aircraft engine, passes through a disconnect, through the ventilation garment, and is exhausted from the suit controller for monitoring and as an emergency pressurization source should the ventilation air be lost.

The exhaust air forces the exhaust diaphragm open and allows the ventilation air to pass to the atmosphere. This same air pressure prevents the actuation of the tilt valve in the demand compartment.

VENTILATION PRESSURIZATION.—As long as the cabin pressurization system is intact and functioning, the ventilation air passes through the controller, being exhausted into the cabin through the exhaust port of the controller. The only suit pressure in this case is caused by the restriction of the flow of ventilation air through the suit and controller (approximately 0.3 inches of mercury for 300 l.p.m.). If cabin pressure is lost below 35,000 feet ambient, these same conditions will exist. However, if the cabin pressure is lost when the aircraft is above 35,000 feet, the suit controller automatically monitors the flow of exhaust gases from the suit to maintain the required differential pressure for a particular altitude. The differential pressure is always that pressure necessary to hold an altitude of 35,000 feet in the suit when the suit is exposed to altitudes higher than 35,000 feet.

Figure 10-10 is a schematic diagram of the suit controller during ventilation pressurization. Anytime cabin pressure is lost, the bellows in the aneroid chamber will expand, and above 35,000 feet will block the bleed port until the pressure (approximately 3.4 p.s.i.) is great enough to compress the bellows away from the bleed port. In this manner a constant absolute pressure of approximately 3.4 p.s.i. is maintained in the aneroid compartment. The oxygen pressure will then build up on the control side of the exhaust diaphragm to a pressure equal to that in the aneroid compartment. To open the exhaust port the pressure of the gas being exhausted from the suit must be greater than the pressure on the control side of the diaphragm. If the pressure of the exhaust gas, and therefore the suit pressure, is less than the control pressure, the exhaust port will remain closed. But when the exhaust pressure is greater than the control pressure, the exhaust valve will open and the suit will have a different pressure equal to the differential pressure of the oxygen in the aneroid compartment with such increase over that differential as will be caused by the restriction of the ventilation flow (approximately 0.25 inches of mercury over the hold pressure for 300 l.p.m.).

AIRCRAFT OXYGEN PRESSURIZATION.—If the jet engine failed, the cabin pressurization, which is dependent

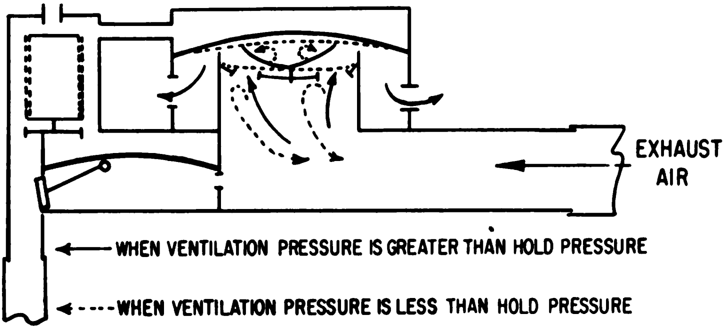

EXHAUST AIR
← WHEN VENTILATION PRESSURE IS GREATER THAN HOLD PRESSURE
← - - - WHEN VENTILATION PRESSURE IS LESS THAN HOLD PRESSURE

Figure 10-10.—Schematic diagram of suit controller during ventilation pressurization.

on the operation of the jet engine, would be lost, and the source of ventilation air for the pressure suit also would be lost. In this case the suit controller, at altitudes above 35,000 feet, would automatically trap the required differential pressure in the suit and, thus, hold an absolute pressure of 3.4 p.s.i. However, under this emergency condition, there is no flow through the suit except the exhaust of exhalation gases; and consequently, there is no ventilation of the suit. When pressurized in this manner, the system becomes static except for exhalation gases and provided there is no suit leakage. If the suit has leakage and if the exhalation gases are not sufficient to make up such leakage, the tilt valve in the demand compartment will be actuated, and oxygen will be supplied to the suit to make up the required differential pressure. It is easy to realize that if oxygen were allowed to circulate through the suit for purposes of ventilation, the aircraft supply or the emergency supply of oxygen would be depleted in a very short time.

Aircraft oxygen pressurization is illustrated in figure 10-11. When the suit pressure is less than the pressure in the aneroid compartment the higher pressure is, in turn, greater on the control side of the demand diaphragm. The demand diaphragm will depress the tilt valve, allowing oxygen to flow directly through the controlled sections to maintain the required differential pressure in the suit.

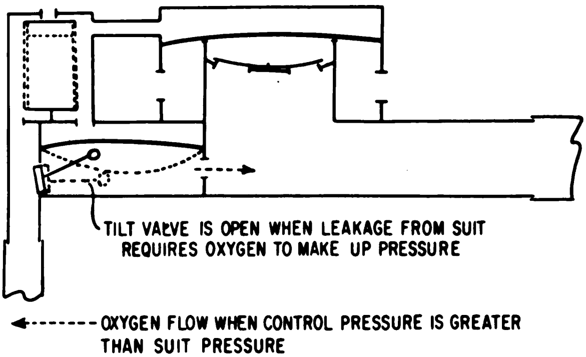

TILT VALVE IS OPEN WHEN LEAKAGE FROM SUIT REQUIRES OXYGEN TO MAKE UP PRESSURE
◄-------OXYGEN FLOW WHEN CONTROL PRESSURE IS GREATER THAN SUIT PRESSURE

Figure 10-11.—Schematic of suit controller, pressurizing with oxygen.

Ambient pressure at 35,000 feet is 3.4 p.s.i., and at 60,000 feet the pressure is 1.0 p.s.i. The cabin is pressurized to an altitude of 22,500 feet, which is an absolute pressure of 6.0 p.s.i. or a differential pressure at 60,000 feet of 5.0 p.s.i. (6.0 p.s.i. (22,500 feet) - 1.0 p.s.i. (60,000 feet) = 5 p.s.i.). If this cabin pressure is lost when flying at 60,000 feet, the suit controller will monitor the exhaust of gas from the suit until the differential pressure within the suit is reduced from 5.0 p.s.i. (cabin differential pressure) to 2.4 p.s.i. and will hold this pressure as long as the aircraft remains at 60,000 feet. The combined ambient pressure of 1.0 p.s.i. and suit differential pressure of 2.4 p.s.i. is 3.4 p.s.i.; therefore, an environmental altitude of 35,000 feet is maintained within the suit.

If the pilot should descend to 45,000 feet (ambient pressure, 2.1 p.s.i.), the suit controller would exhaust gas from the suit until the differential pressure within the suit is reduced to 1.3 p.s.i. (1.3 p.s.i. + 2.1 p.s.i. = 3.4 p.s.i., thus the environmental altitude remains at 35,000 feet).

BAILOUT OXYGEN PRESSURIZATION.—In case of an emergency and the pilot must bail out, the bailout system, located in the seat kit assembly, will provide breathing oxygen and act on the suit in exactly the same manner as that described above for "Aircraft oxygen pressurization." The bailout system may be actuated upon entering the aircraft if means are provided to warn the pilot when the emergency supply is in use. When no warning system is provided, the bailout system is actuated just prior to bailout. The bailout system operates the same as the aircraft oxygen pressurization; thus, there is no actual flow of oxygen through the suit for ventilation purposes. The bailout unit will supply breathing oxygen and will also supply oxygen to maintain the required differential suit pressure that might otherwise be lost by suit leakage.

The oxygen is delivered from the bailout cylinder in a manner described in the following section.

BAILOUT UNIT

The bailout unit is mounted in the seat pan of the ejection seat. A schematic diagram of the bailout unit and its components is shown in figure 10-12. The bailout unit serves a dual purpose—it provides an emergency supply of breathing oxygen and an emergency source of pressurization. All the services to the pilot are provided automatically.

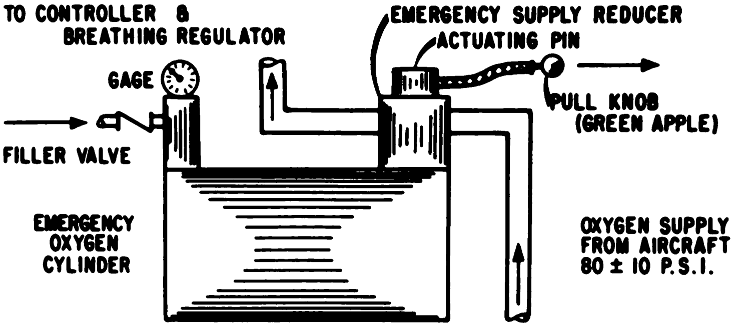


Figure 10-12.—Schematic diagram of bailout unit.

Operation

When the locking pin is pulled from the top of the pressure reducer, a spring in the upper part of the reducer is allowed to descend against a diaphragm. The spring exerting pressure on top of the diaphragm is preset to balance a pressure of 60 p.s.i. (gage). When the pressure on the opposite face of the diaphragm decreases, the spring moves the diaphragm against the stem of a valve located in the lower portion of the reducer. The actuation of this valve supplies oxygen from the bailout cylinder until the diaphragm is moved up against the force of the spring. Thus, oxygen from the cylinder at pressures from 250 to 1,800 p.s.i. is supplied at a reduced pressure of 50 ± 10 p.s.i.

Automatic Bailout System

The normal route of the oxygen aircraft supply is through the emergency system reducer so that the oxygen passes under the previously described diaphragm. The aircraft oxygen is supplied at a pressure of 80 ± 10 p.s.i.

Therefore, the diaphragm is prevented from actuating the valve by a pressure greater than the preset spring pressure.

At any time the aircraft oxygen is depleted to the extent it will not deliver a pressure greater than 60 p.s.i., the pressure against the bottom of the diaphragm will be inadequate. This allows oxygen from the bailout cylinder to flow to the suit controller and pilot. Therefore, at any time the aircraft oxygen drops below 60 p.s.i. the bailout cylinder will take over. The automatic system allows the emergency system to be actuated upon entering the aircraft and after the aircraft supply is turned on; however, this system is not used unless a device is provided to warn the pilot that he is using emergency oxygen.

Without a warning device, the bailout unit could take over and in a very short time the pilot would be without even emergency oxygen. Such a warning device is being developed to indicate that the bailout oxygen supply is in use.

The duration of the bailout unit at sea level is 10 to 12 minutes. Duration at suit-controller-hold altitude and above is approximately 20 minutes.

BREATHING REGULATOR

The Firewel GR-90 regulator shown in figure 10-13 delivers 100 percent oxygen under a slight positive pressure of 1.5 inches of water. It operates on 40 to 90 p.s.i. inlet pressure. The GR-90 oxygen breathing regulator performs the following functions:

1. Supplies breathing oxygen to the respiratory section.
2. Defogs the visor.
3. Supplies pressure to the visor pressure seal.

Construction

A schematic diagram of the Firewel GR-90 regulator is shown in figure 10-14. The case of the regulator is made of cast aluminum and is divided into two main compartments—reference suit pressure compartment and respiratory pressure compartment.

These two compartments are separated by a silicone diaphragm. The diaphragm is spring loaded in the reference suit pressure compartment to deliver a positive

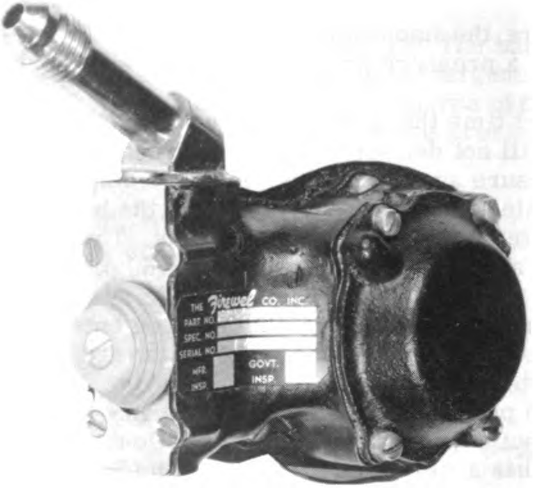


Figure 10-13.—Firewel GR-90 oxygen breathing regulator.

pressure of 0.5 to 1.5 inches of water. A tilt valve stem extends into the respiratory pressure compartment.

The GR-90 regulator has two pressure-sensing lines. One line, commonly referred to as the compensating line, senses suit pressure to the reference suit pressure compartment. The other line senses pressure from the respiratory section of the headpiece to the respiratory pressure compartment of the regulator.

A two-position ON and OFF button controls the supply of oxygen to the regulator and controls inflation and deflation of the visor seal. The visor seal is inflated when the control button is in the ON position. The seal pressure is controlled by a spring-loaded valve. The pressure for the visor seal is tapped off the oxygen delivery upstream of the tilt valve. This is referred to as the lower chamber. Deflation of the visor seal is automatically accomplished by placing the ON-OFF button in the OFF position. The visor may then be opened.

Operation

The oxygen supply flows from the inlet to the upper valve chamber. When the oxygen supply control button is in the ON position, the oxygen flow is directed to the tilt valve and also inflates the visor seal.

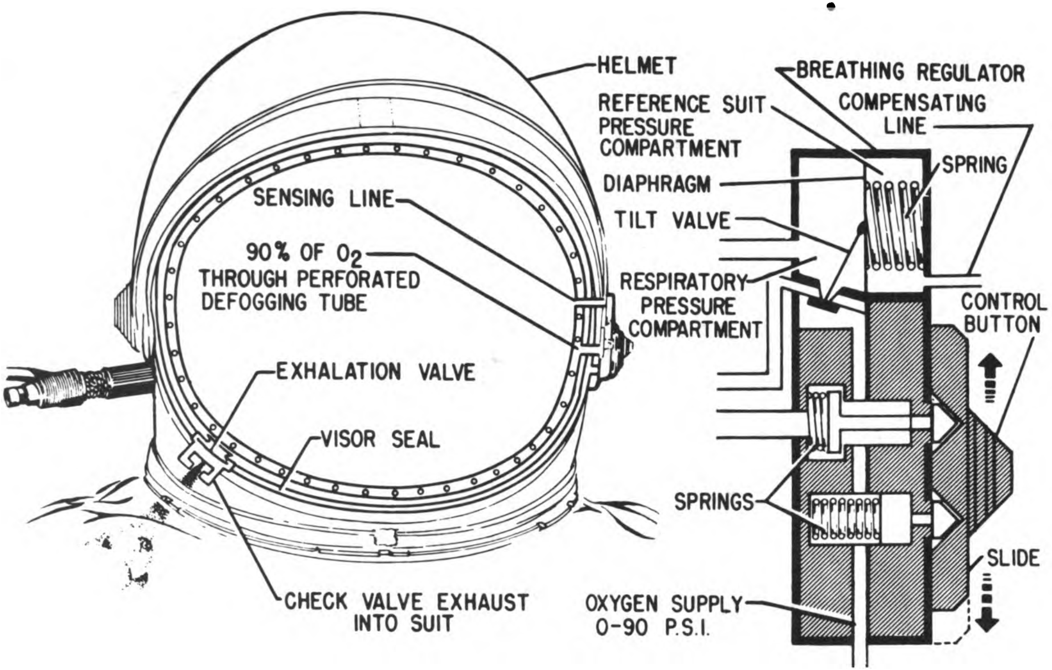

HELMET
BREATHING REGULATOR
REFERENCE SUIT PRESSURE COMPARTMENT
COMPENSATING LINE
SPRING
DIAPHRAGM
TILT VALVE
SENSING LINE
90% OF O_2 THROUGH PERFORATED DEFOGGING TUBE
RESPIRATORY PRESSURE COMPARTMENT
CONTROL BUTTON
EXHALATION VALVE
VISOR SEAL
SPRINGS
SLIDE
CHECK VALVE EXHAUST INTO SUIT
OXYGEN SUPPLY 0-90 P.S.I.

Figure 10-14.—Schematic diagram of Firewel GR-90 oxygen breathing regulator.

The suit pressure is sensed in the reference pressure compartment. This pressure, in addition to the 1.5-inch water pressure applied by the spring, is exerted on the diaphragm. This combined pressure distends the diaphragm, depressing the tilt valve stem, which, in turn, unseats the tilt valve. This operation allows approximately 90 percent of the oxygen to flow from the tilt valve through the defogging tube and into the respiratory section of the headpiece. The remaining 10 percent flows through the tilt valve and through the respiratory pressure compartment and thus to the respiratory section of the headpiece.

The defogging tube follows the perimeter of the visor. As mentioned before, the defogging tube has perforations which cause the incoming oxygen to wash across the visor, accomplishing the defogging.

The oxygen flow will pressurize the respiratory section of the headpiece until it is equal to the reference pressure side of the diaphragm. This pressure applied to the bottom of the diaphragm returns it to its neutral position, allowing the tilt valve to close; thus the flow of breathing oxygen ceases.

If the pressure of the respiratory section of the headpiece was transmitted to the reference pressure compartment through the defogging tube, the tilt valve would be kept open too long, putting too much pressure in the respiratory section of the headpiece. To overcome this difficulty, approximately 10 percent of the flow of oxygen is diverted along the tilt valve stem into the respiratory pressure compartment. In this manner, the pressure is built up in the respiratory pressure compartment at the same time as in the respiratory section of the headpiece. The tilt valve remains seated until the pressure in the respiratory compartment falls below that of the reference pressure compartment (suit pressure plus spring force).

Attachment

The headpiece shell acts as a base plate for attachment. The regulator is attached by three screws on the lower left side. The sensing and delivery tubes pass through the headpiece shell to the proper component.

AIRCRAFT COMPONENTS

In order for the full pressure suit to be used successfully, certain accessory equipment must be incorporated in the aircraft. A thorough understanding of this equipment is as important as the full pressure suit itself.

Accessory Equipment

The following accessory items are incorporated into one panel: pressure reducer, ventilation air control valve, inlet fitting for external ventilation air, oxygen gages, and control knob for temperature selection.

PRESSURE REDUCER.—The oxygen pressure reducer is cam-lever-operated and works on the same principle as the bailout pressure reducer. The pressure reducer is preset to deliver 80 ± 10 p.s.i. This reducer is not used when the aircraft is equipped with a liquid oxygen system. An OFF-ON valve is used in this case. In either case, there is a safety valve that will pop off at 120 ± 10 p.s.i.

INLET FITTING FOR EXTERNAL VENTILATION AIR.—This inlet fitting is similar to the female fitting on an oxygen feeder hose. A dust cover is utilized to prevent foreign matter from entering the valve. The inlet fitting is a component of the ventilation flow control valve, described below.

GAGES.—A standard 1,800 p.s.i. high-pressure gage and shutoff valve are used when the aircraft has a gaseous oxygen system. A liquid oxygen quantity gage is used for a liquid system.

VENTILATION FLOW CONTROL VALVE.—The ventilation flow control valve is shown in figure 10-15. The valve has 3 selections: OFF, AIRCRAFT VENTILATION, and EXTERNAL VENTILATION, as shown in the schematic diagram.

It is sometimes necessary for the wearer to don the suit a considerable time prior to takeoff. Inasmuch as the full pressure suit is an airtight, sealed garment, body heat would soon raise the temperature and humidity to an uncomfortable level. Since normal suit ventilation air is dependent upon the engine, it is necessary that an external air source be provided to ventilate the suit prior to engine turnup.

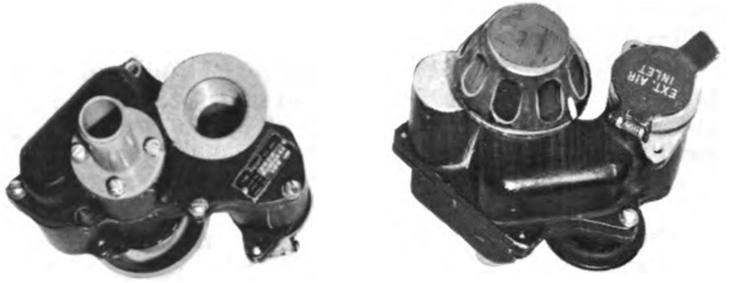


Figure 10-15.—Ventilation flow control valve (Firewel F-2020C).

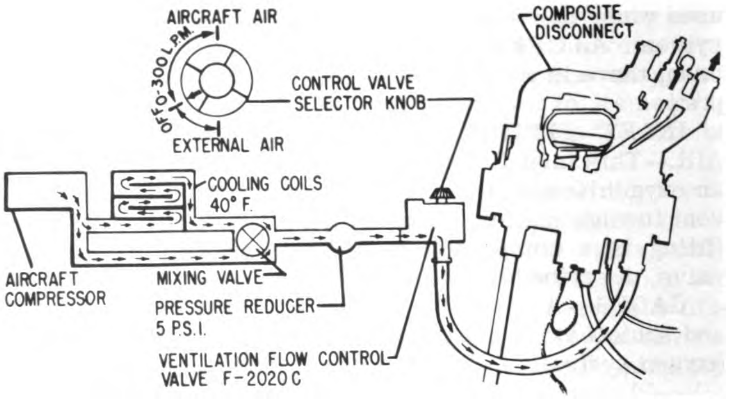


Figure 10-16.—Schematic of aircraft ventilation system.

The external air source is used as follows: After preflight check and hookup, set the console ventilation air selector knob to EXTERNAL AIR. Since the aircraft will be in a standby status, the oxygen will be on. With the visor closed and the oxygen supply button turned on at the headpiece, lift the dust cover, and plug into the external air fitting. If at any time ventilation is attempted with the oxygen off, the headpiece or the gloves should be removed. Ventilation should never be attempted with only the visor open. The flow is preset; therefore, the pilot will have no control over regulating the flow.

Just prior to engine start, remove the hose from the external air fitting. Depress and rotate the ventilation flow control knob clockwise until it pops up. Regulate the flow to the ventilation garment by rotating the knob clockwise to increase the flow.

Ready-room ventilation is also provided for, because it is assumed that flight personnel will be dressed prior to briefing. This period may last from a half-hour to several hours.

To meet this problem, an air outlet is provided at each seat in the ready room. Using an auxiliary power source, ventilation air can be supplied to each pilot. By this system, each person keeps comfortable by ventilation air. The ventilation air may be delivered at a predetermined temperature and flow, or individually selected by the seat occupant.

ASSISTING PROCEDURES

In the course of his work in the full pressure suit field, a Parachute Rigger will be required to assist flight personnel with their suit systems. In order to render this assistance, the Parachute Rigger must be thoroughly familiar with the proper donning and doffing procedures, cockpit hookup and testing, care, and maintenance of the suit systems.

Ready-Room Assisting Procedures

The pilot should require only a minimum of assistance in donning the suit system, but in order to facilitate the donning, the following should be observed:

Before donning of the suit, make a visual inspection to determine the completeness of the entire suit assembly.

All tiedown straps should be free of buckles.

Neck section and foot section zippers should be open.

Snap fasteners in neck section should be open.

Entrance zipper should be open (waist gusset zipper closed at this time).

Visually inspect that O-rings are present in suit port fittings; i.e., vent air, anti-g, suit exhaust, etc. If no anti-g suit is to be used, make sure that the port is plugged.

Inspect the pressure sealing lips on the entrance zipper and lubricate with Dow Corning DC-4 if required.

Check to see that the O-ring is present in the helmet and is seated properly.

Clean the headpiece visor inside and out and apply antifogging solution if needed.

Check helmet for operational suitability and completeness of assembly.

Engage oxygen hose and communication plug.

Lower retractable clear visor.

Turn oxygen on at console and actuate slide valve on regulator to ON position.

Check visor for effective seal.

Turn oxygen off at console and check visor for effective seal.

Deflate visor seal, open visor, and check communications system.

Check flotation garment for completeness of assembly, making certain that live CO_2 cartridges are present and canister secured (flotation garment should be evacuated of trapped air before donning).

With the predonning inspection completed, the suit is now ready for donning.

The following procedure is suggested for maximum wearer comfort, minimum donning time, and proper operation of the suit.

Donning Procedure—Mk IV Full Pressure Suit

The step-by-step procedure for donning the full pressure suit is as follows:

1. Don waffle weave underwear (fig. 10-17) (for cold weather operations).

2. Don prescribed cotton undergarment and woolen socks (fig. 10-18). Pull socks up smoothly over legs of undergarment. (Prescribed cotton undergarment has Trilok patch on right side, adjoining suit exhaust port, and in upper thigh areas of legs.)

3. Don anti-g suit (optional). (See fig. 10-19.) Attach at waist first, then zip up legs, smoothing out undergarments.

4. Don lightweight full pressure suit as follows:

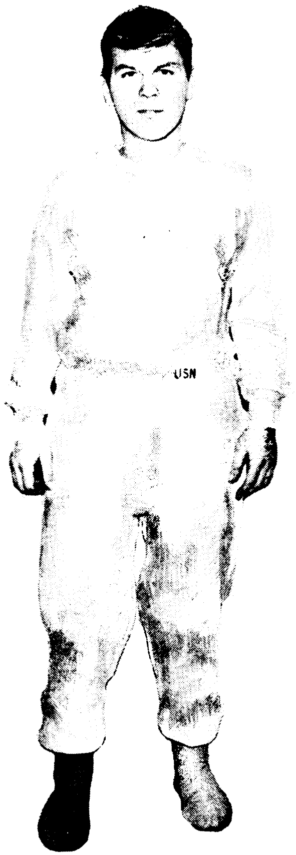


Figure 10-17.—Waffle weave underwear for use in cold climates.

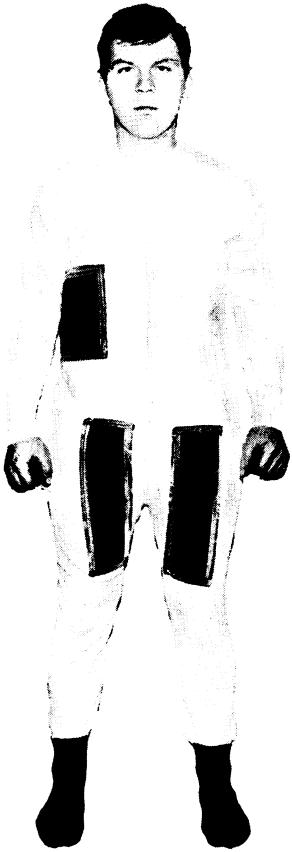


Figure 10-18.—Cotton undergarment, showing Trilok screens.

Assume a seated position and insert one leg into corresponding leg of the body section (fig. 10-20). Insert the other leg, then stand and pull suit over hips (fig. 10-21).

Assume sitting position and adjust stockinettes to fit feet comfortably, engage and close ankle zippers, and don boots (fig. 10-22).

Assume standing position and insert one arm (fig. 10-23), then the other through corresponding arm section.

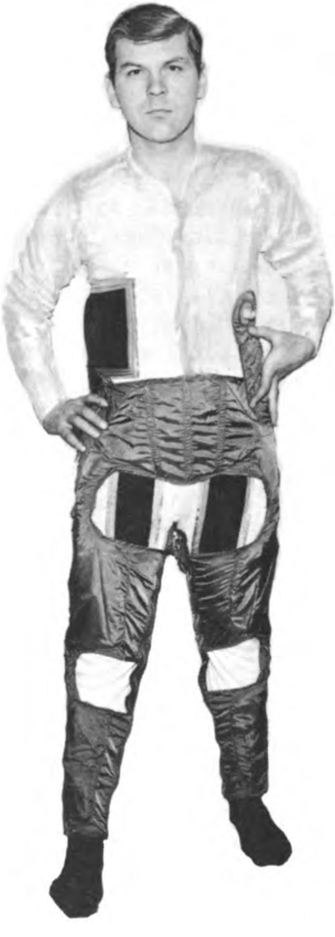


Figure 10-19.—Anti-g suit (Z-3 cutaway modified).

Open the waist gusset zipper completely to assure elongation of torso section (fig. 10-24).

Support neck bearing section over and above head and "roll" head through neck bearing assembly (fig. 10-25).

Visually inspect the relief port in the inner liner—IT MUST BE SECURED.

Close the waist gusset zipper, making sure the inner liner is free of the zipper slider when closing.

Close the neck zipper and snap fasteners in the neck section.

Close the entrance zipper (fig. 10-26), taking care to pull in line with the zipper chain, and making sure the slider is pulled securely into the closure ending.

NOTE: At this point the Parachute Rigger connects the suit to the ventilation air supply for wearer comfort. The procedure is as follows:

Insert chest strap through buckle and adjust to predetermined marking.

Parachute Rigger inserts rear tiedown straps through buckles and adjusts to predetermined markings (fig. 10-27).

Insert upper front tiedown strap through buckle (this strap should not be adjusted to marking until after helmet is engaged).

Insert lower front tiedown straps through buckle.

Insert left and right side tiedown straps through buckle.

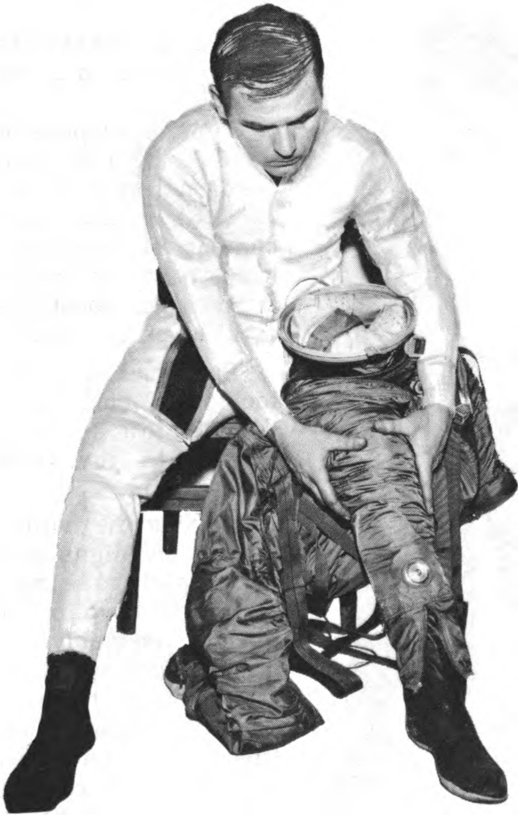


Figure 10-20.—Inserting leg into leg section.

Lower front and side tiedown straps should be tightened just enough so that the wearer does not have to stoop while standing.

The lower front and side tiedown straps provide final adjustment when seated in the cockpit.

Caution: Tiedowns must be adjusted to predetermined markings when seated to prevent headpiece and upper portion of body section from lifting when the suit is pressurized.

Before donning helmet, loosen internal suspension of headpiece if needed (rotate external knob).

Grasp ear cushions with tips of thumbs (fig. 10-28), and pull headpiece over head position ear cushions.

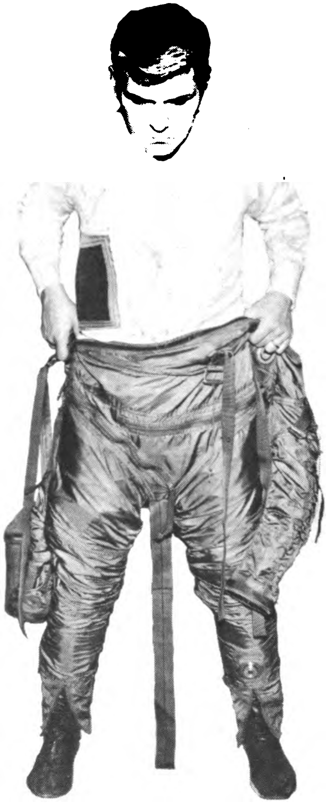


Figure 10-21.—Adjusting suit over hips.

Locate flexible face seal and conform to symmetry of face.

Tighten suspension to effect face seal integrity by rotating external knob (fig. 10-29). (A mental note of the number of rotations will insure ease of doffing when applying a counterclockwise rotation of the knob.)

Parachute Rigger locates locking mechanism which is located (on neck bearing) slightly to the right of the pilot's chin.

Holding the helmet in position, he aligns and inserts the base of the helmet into the mating groove of the neck bearing assembly. This can be best accomplished by placing the right thumb over the edge of the lowermost portion of the visor opening and extending the remaining fingers of that hand under the neck bearing, at the same time placing the left thumb on the oxygen hose (near communication terminals) and extending the remaining fingers of that hand under the neck bearing. With the hands in this position exert a downward force, and when the helmet is seated properly, engage the lugs by rotating the locking mechanism to front and center of the pilot's chin until the detent is engaged.

Caution: In securing the headpiece to the neck bearing, care should be taken not to displace the O-ring. A very light film of DC-4 (Dow Corning 4) compound on the O-ring facilitates mating.

Insert hands into gloves and adjust for comfort.

Parachute Rigger engages and only starts zipper.

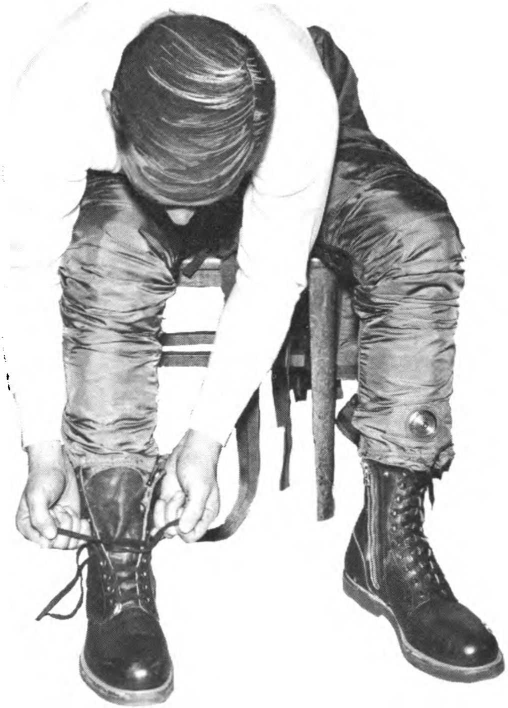


Figure 10-22.—Donning and adjusting boots.

Parachute Rigger engages disconnect, making sure that the O-ring is not displaced in the process.

Parachute Rigger completes closure of the disconnect zipper.

Adjust and fasten wrist strap.

Adjust palm restraint (if needed).

Parachute Rigger connects hose fittings to the torso, making sure that the nozzles are secure in suit fittings.

Preflight Assistance

After the pilot enters the cockpit he should adjust his torso tiedowns to their predetermined markings. The PR should then assist in attaching the parachute, inertia reel, and seat belt to the harness, and assist in connecting

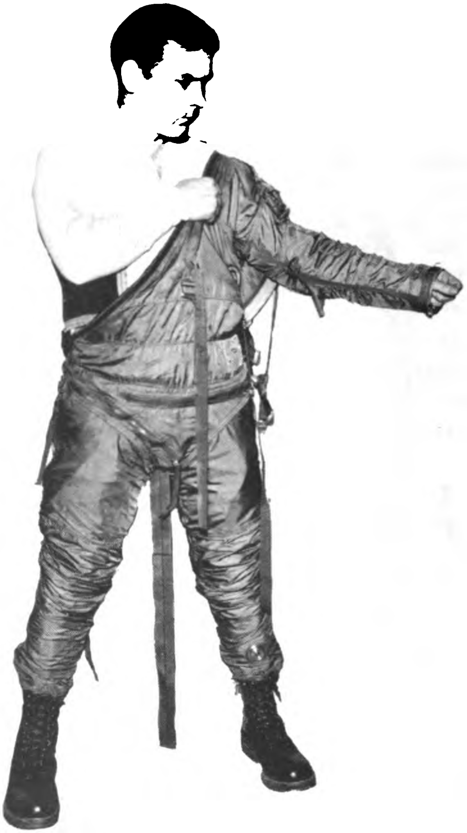


Figure 10-23.—Inserting arm through arm section.

the services from the aircraft to the suit, making certain that the GR-90 regulator is in the OFF position before turning on the aircraft oxygen supply. Check for operation, pressure, and quantity. Pull the pin on the bailout unit only if the aircraft is equipped with the warning system for automatic bailout. The pilot is now ready to close his visor, turn on his breathing oxygen and ventilation air, and check his communications system.

Postflight Procedure

On landing, the pilot usually has his breathing oxygen and ventilation air turned off and his visor open. In such

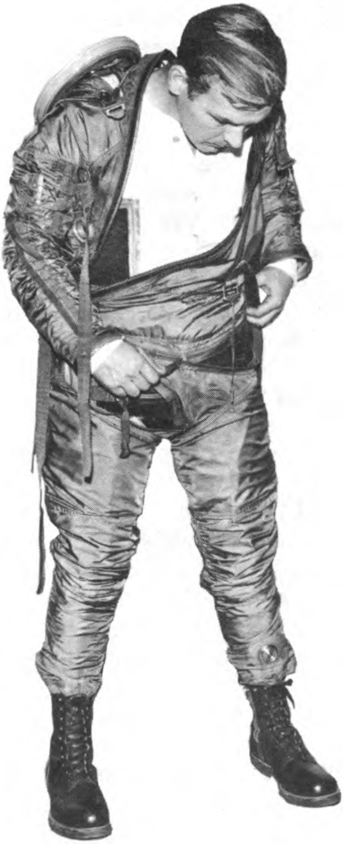


Figure 10-24.–Opening waist gusset zipper.

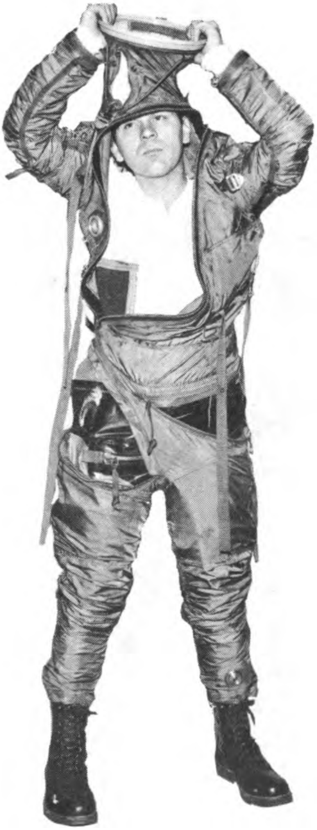


Figure 10-25.–Inserting head through neck section.

an event, render assistance in releasing the parachute, inertia reel, lap belt, tiedown, and also the connecting services from aircraft to suit.

Doffing Procedure

The following procedure, with assistance as required, is recommended for simplification and ease of doffing the suit system:

1. Parachute Rigger disconnects and removes hose nozzles from the suit port fittings.

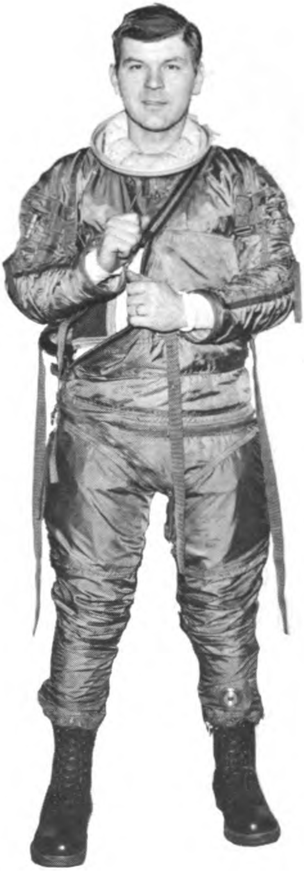


Figure 10-26.—Closing the entrance zipper.

2. Remove flotation garment and harness assembly with Parachute Rigger assistance.

3. Disengage headpiece by releasing the detent in the locking mechanism on neck bearing. This is accomplished by rotating the locking mechanism slightly to the right of the chin. With the lugs disengaged, hold the locking mechanism and move the head upward. This action should separate the headpiece from the neck bearing.

4. Disengage zippers on gloves, unsnap wrist restraint, disengage disconnect, and remove gloves.

5. Parachute Rigger removes straps from buckles on rear tiedown assembly.

6. Open entrance zipper completely.

Open waist gusset zipper completely.

Grasp neck bearing with both hands, lift up, and at the same time depress head slightly and move forward and out of neck section.

7. With the right hand, grasp the chest strap and pull outward. (This action should remove the shoulder cap of the suit from the man's shoulder.)

Now locate the right arm in the area of the small of the back and with the left hand grasp the sleeve of the right arm and remove right arm from suit.

Remove left arm from suit section and close waist gusset zipper.

Lower suit to area of knees.

Remove boots.

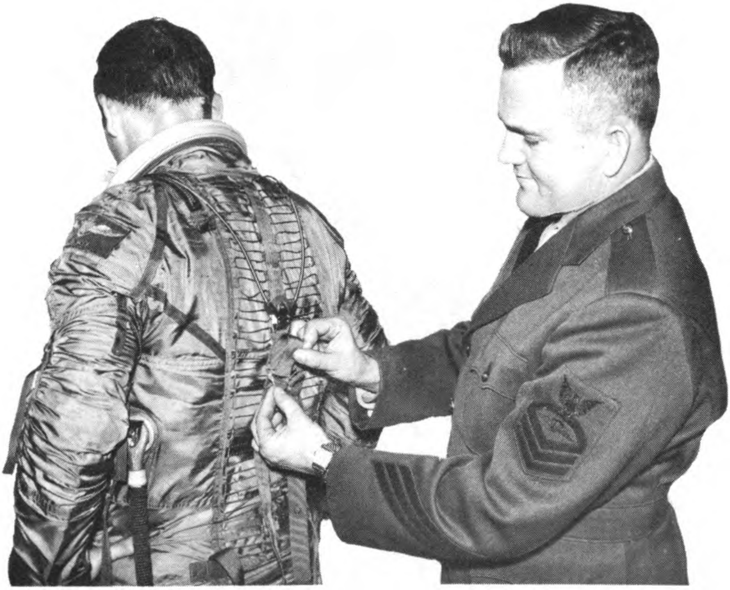


Figure 10-27.—PR inserting rear tiedown straps.

Open ankle zippers.

Remove suit completely.

Upon removal of suit, Parachute Rigger should insert a clothes hanger through the entrance zipper into the neck section, close the entrance zipper, and hang the suit in the storage area to ventilate and dry.

PREVENTIVE CARE AND MAINTENANCE

If the full pressure suit is to operate as intended, it is necessary that ground personnel insure that preventive maintenance be performed with care.

Underwear

The underwear, after wearing, may become dampened by perspiration. It should be laundered as needed. It may be laundered in an automatic washer or by hand, using warm water and a mild soap. It should be hung to

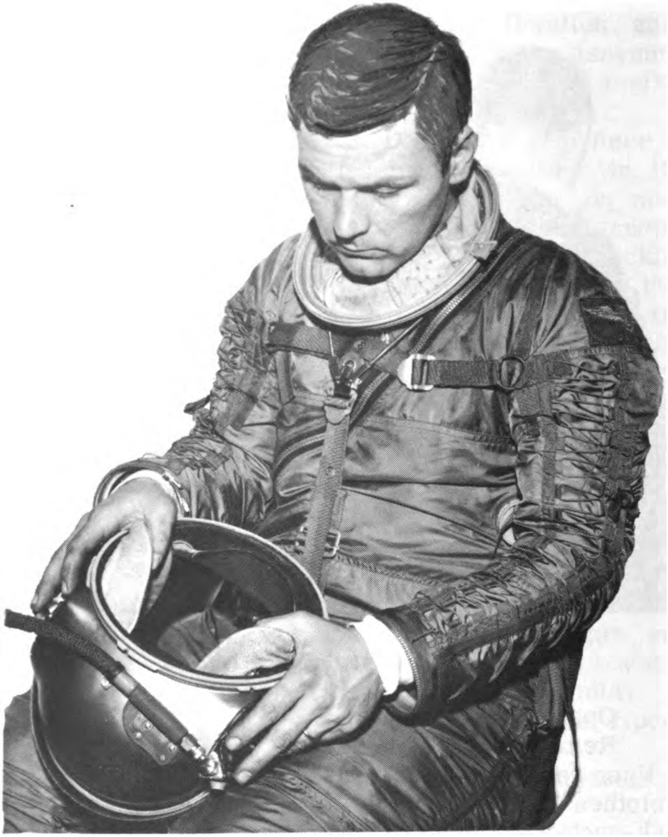


Figure 10-28.—Spreading earcups.

dry or tumble dried in an automatic drier with only warm air. Rapid drying may cause excessive shrinkage. If the Trilok screens are adhered to the garment by use of "Velcro" tape, the screens should be removed before laundering and replaced after the garment is dry.

Anti-g Suit

The cutaway anti-g suit should be cared for in the same manner as the standard anti-g suit. Bladders should be periodically inflated and checked for leakage, and the inlet connection should be checked to make sure

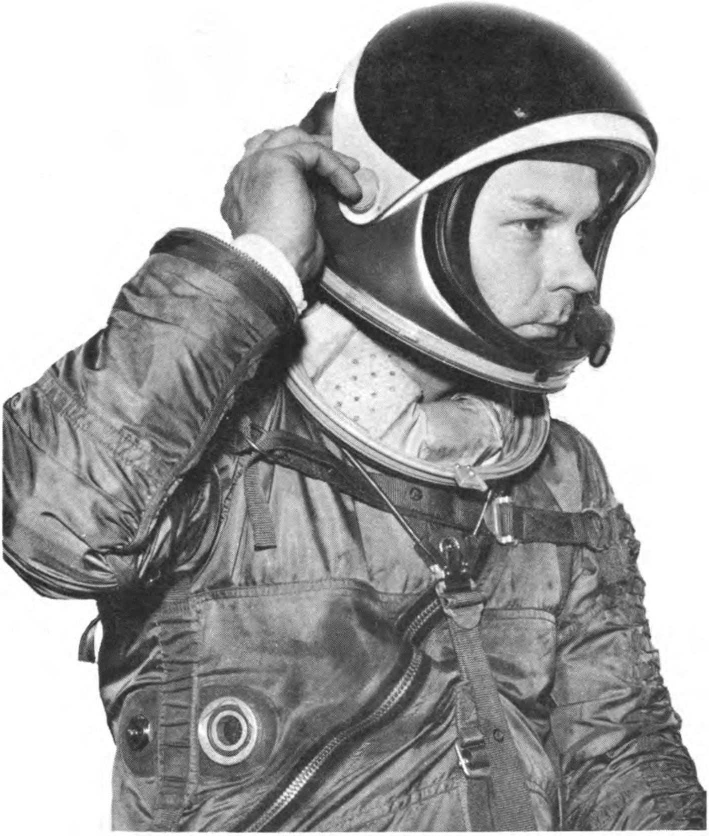


Figure 10-29.—Effecting an airtight seal.

it makes proper connection with the anti-g suit port fitting.

Torso

Extreme care should be exercised at all times with the torso section. Care should be taken to eliminate sharp projections which could puncture or snag the torso in all areas where suits are handled or worn.

A periodic visual inspection should be made on all torso components and should include the following important points:

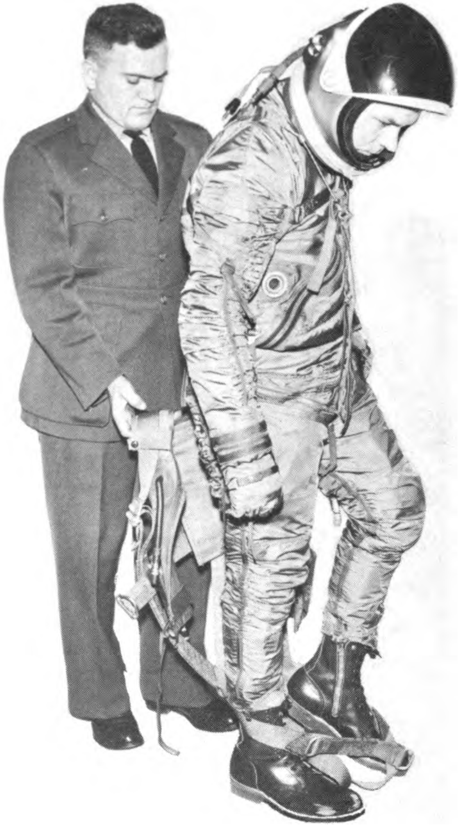


Figure 10-30.—PR assisting in donning of flotation garment and harness assembly.

The outer garment should be free of snags and should not show excessive wear.

The neck bearing should turn freely. Several drops of Dow Corning Silicone Fluid should be applied between the races periodically. This can be readily accomplished by injecting a hypodermic needle containing the fluid in the recess found on the underside of the neck bearing. With an accumulation of grit or wear, a resistance of the bearing to rotate freely may be encountered. When this occurs, the bearing must be disassembled and cleaned as follows: Remove the retaining ring lock screw, retaining ring, backup ring, guard ring, and Teflon seal. Being very careful, separate the inner and outer race and remove the ball bearings. Clean the balls with Freon 113 and dry thoroughly. Repack the ball bearings in the outer race with Dow Corning Silicone Oil. (The correct number of balls is a full race minus one.) Reassemble the bearing in reverse order of disassembly.

The pressure sealing entrance zipper and relief zipper should be inspected for tears in the rubber sealing lips and loose or missing zipper teeth, and should be free of dirt or other residuals. The zipper sliders should operate freely. A light film of silicone grease, Spec. MIL-L-4343A (Dow Corning Type 33 Silicone Grease) should be applied to the rubber zipper lips periodically as needed to give easy operation.

All port fitting nozzles and plugs should lock and unlock freely.

A visual inspection should be made by the PR prior to all pressure suit flights and should be followed by a ground level pressurization of the entire suit (empty) prior to donning. The suit should be pressurized to 2.0 p.s.i. and the leakage rate determined. The leakage rate must not exceed 20 l.p.m. Boots must enclose the sock ending whenever the torso is pressurized. On occasion the suit should be pressurized between 3.5 and 4.0 p.s.i. in order to test the "pop off" characteristics of the pressure relief valve. Two of the most critical areas of the torso are the pressure sealing entrance zipper and the relief zipper in the front crotch area. Avoid excessive pulling when opening and closing the zipper sliders, and take care that no straps or fabric become jammed in these zippers.

Whenever opening or closing zippers, take care that the suit plies do not get caught under the slider or between zipper teeth.

Take care not to strike the neck bearing with anything. It may be knocked out of round, making it difficult to turn.

Do not permit the wearer to apply too much force to the stretchable sock ending during donning or removal.

After wear, always dry and ventilate the torso, gloves and helmet before storage.

It is suggested that the torso be hung on a clothes hanger extended through the neck section. The entrance zipper should be closed within 2 inches of the closed end seals so that the slider does not rest on the end seal.

If the suit is immersed in salt water, it should be worn into a fresh water shower to remove brine.

Gloves

The gloves should be inspected periodically to make sure that there are no obvious tears or cuts. Check the zipper for damaged or missing teeth. Make sure the O-ring is not damaged and that the O-ring is lubricated. An occasional application of a good leather dressing, such as Neatsfoot oil, to the leather will keep it soft and pliable after wetting.

Shoes

Shoes should be cared for like any good footwear. They should be inspected periodically for obvious damage or excessive wear. Also keep good laces in the boots.

Flotation Garment

The garment should be cared for in the same manner as a standard inflatable life preserver. It should be inflated periodically and checked for leaks in the bladders. A visual inspection should be made for completeness of assembly and any indication of obvious damage.

For any prolonged storage it is suggested that the garment be partially inflated in an extended position to prevent sharp creases in the bladders.

Evacuate as much air as possible from the bladders. Any trapped air expands at high altitudes and will partially inflate the garment.

Helmet

The helmet should be handled carefully at all times. A carrying bag is provided with each helmet, and it is recommended that the helmet be kept in its carrying bag when not in use. The sponge face seal should be handled carefully during donning and doffing to prevent tearing the soft sponge. The metal ring at the base of the helmet should be protected from bumps or rough handling which may damage it and prevent proper engagement with the neck bearing.

Never use the oxygen hose for a handle. This hose contains communication system wiring which could be damaged by rough handling.

The plastic visor and tinted lens should be cleaned as needed. Use only a nonabrasive soap and clean water to remove dirt. Grease may be removed with hexane, kerosene, or white gasoline. Use only a soft cloth to apply the cleaning agent. Never rub the surface with any abrasive. Keep aromatic fuels away from the visors as they may cause surface crazing.

Antifogging Solution (Federal Stock No. RN-6850-200-2397-G500) is recommended for use on the visor to prevent fogging. Use care in applying a thin film with cotton swab to avoid scratching the plastic visor. Lightly remove excess after drying for a few minutes. Leave the oxygen regulator ON-OFF button in ON position, when not in use, to avoid permanent set in shutoff O-ring inside regulator.

A periodic check of the helmet should be made for obvious damage and should include a check of the following areas:

Clear and tinted visors not cracked or scratched.

Visors should raise and lower freely, and trunnion latches should operate easily.

Face seal not damaged.

Communications wire connections secure.

Oxygen hose connection tight.

Microphone swivel secured enough to hold position.

Windup adjustment knob should be tight on shaft.

Inflatable seal should hold pressure for at least 30 minutes after shutoff of oxygen supply.

Helmet O-ring should not be damaged.

Helmet should make tight seal when attached to torso neck bearing. Check this during leakage test.

General

All pressure suit equipment should be stored in an area free from dust and dirt and away from excessive heat.

The suit should be dried and ventilated after each wearing.

Avoid smoking while handling or wearing the suit. A spark could melt a hole in the suit fabric. When 100 percent oxygen is being used, a fire hazard is also present.

TESTING

Suit Leakage Test

The pressure suit portable test kit shown in figure 10-31 is required to test the pressure suit for leakage. Figure 10-32 shows a schematic diagram of the test kit, and figure 10-33 is a schematic of the test setup. The test procedure is as follows:

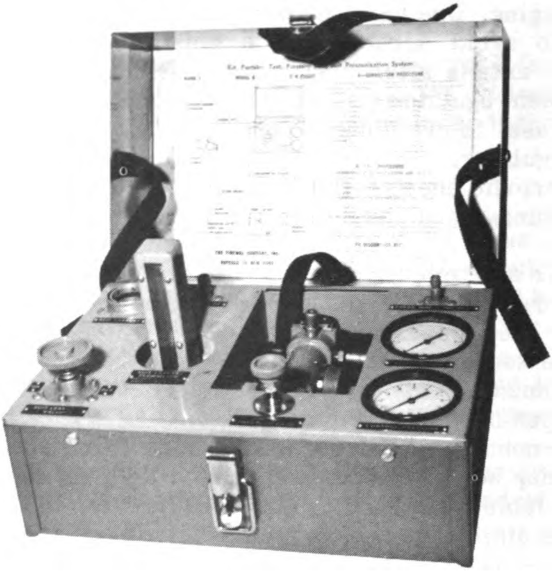


Figure 10-31.—Pressure suit portable test kit.

1. After the pressure suit is set up as illustrated, turn the GR-90 regulator ON just long enough to seal the visor, then turn OFF the oxygen supply but DO NOT move the regulator button to the OFF position. The suit can be inflated with oxygen through the regulator, but it is a waste of oxygen and a slower process.

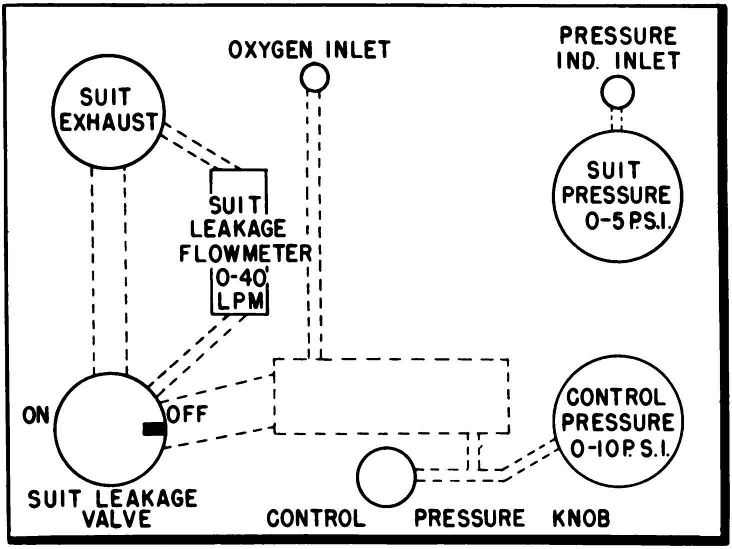


Figure 10-32.—Schematic diagram of test kit.

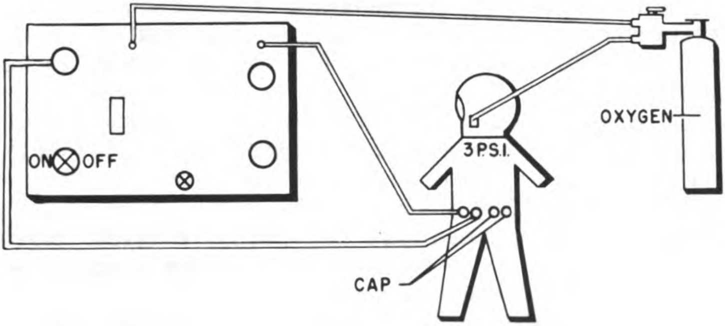


Figure 10-33.—Schematic diagram of test setup.

2. Turn the air valve ON, and by adjusting the control pressure knob clockwise, inflate the pressure suit to 2 p.s.i. as indicated on the pressure gage on the test kit. Turn the air valve OFF.
3. Turn the suit leakage valve to the ON position.

4. The leakage, if any, will be indicated on the suit leakage flowmeter.

5. The maximum allowable leakage is 20 l.p.m.

Testing Suit Components

The components of the full pressure suit are to be tested every 30 days. These tests are to be performed on the OTS-565 test stand which has been modified in accordance with NavAer 17-15BC-505 (Revised 1959).

MODIFYING THE OTS-565 TEST STAND.—A kit is available for making the following changes (see fig. 10-34):

1. Oxygen line tapped into the supply source which flows into the chamber through the input Vol-O-Flo element. This is used to check the exhalation of the regulator to the headpiece.
2. A 100,000-foot altimeter for attaining higher altitudes than the limits of the aircraft altimeter equipped with the test stand.
3. Surge (ballast) tank to permit an even rise and fall of the pressure-suction manometer.
4. Piezometer ring with the aircraft altimeter attached.

NOTE: All valves must be closed at the onset of each test.

DEMAND VALVE LEAKAGE TEST.—The piping setup for performing the demand valve leakage test is shown in figures 10-34 and 10-35. The test procedure is as follows:

1. Connect the suit controller to the test chamber oxygen inlet by means of the oxygen fitting. This test is performed under sea level conditions.
2. Open the oxygen supply valve.
3. Open the oxygen gage low-pressure cutoff valve.
4. Adjust the oxygen pressure by means of the pressure reducer to read 70 p.s.i.
5. There shall be no leakage from the suit exhaust air inlet nor from the exhaust outlet. This may be determined by listening and/or by soaping the ports.
6. At the end of the test close the oxygen supply valve (not shown).
7. Open the relief valve until the low-pressure gage reads zero.

8. Close the oxygen gage low-pressure cutoff valve and the pressure reducer.

9. If leakage was tested by use of a soap solution, the controller must be immediately wiped clean and dry to prevent corrosion. Do not let soap solution enter the aneroid compartment.

CONTROLLER CASE AND EXHAUST VALVE LEAKAGE TEST.—The setup for this test is shown in figures 10-34 and 10-35. The procedure is as follows:

1. Connect the suit controller to the test stand oxygen inlet, by means of the oxygen fitting. The chamber is not decompressed during this test.
2. Open the oxygen supply valve.
3. Open the oxygen gage low-pressure cutoff valve.
4. Adjust the oxygen pressure by means of the pressure reducer to read 5 p.s.i.
5. Cap the suit exhaust air inlet to prevent flow of air.
6. Remove the screen covering the aneroid compartment relief port. Place a rubber stopper on this port and hold in place with a C-clamp, taking care not to damage the controller. Keep the port closed throughout the test and hold for at least 10 minutes before checking for leakage.
7. Check case and controller exhaust port for leakage by listening and/or by soaping.
8. There shall be no leakage.
9. At the end of the test close the oxygen supply valve.
10. Open the relief valve until the low-pressure gage reads zero.
11. Close the oxygen gage low-pressure cutoff valve and the pressure reducer.

ANEROID COMPARTMENT RELIEF PORT TEST FOR REQUIRED BLEED.—The setup for this test is shown in figure 10-34. The procedure is as follows:

1. Connect the suit controller to the test chamber oxygen inlet, by means of the oxygen fitting.
2. Open the oxygen supply valve.
3. Open the oxygen gage low-pressure cutoff valve.
4. Adjust the oxygen pressure by means of the pressure reducer to read 70 p.s.i.
5. Attach a hose to the 400 cc./min. rotameter (not shown) which is provided on the face of the test stand.

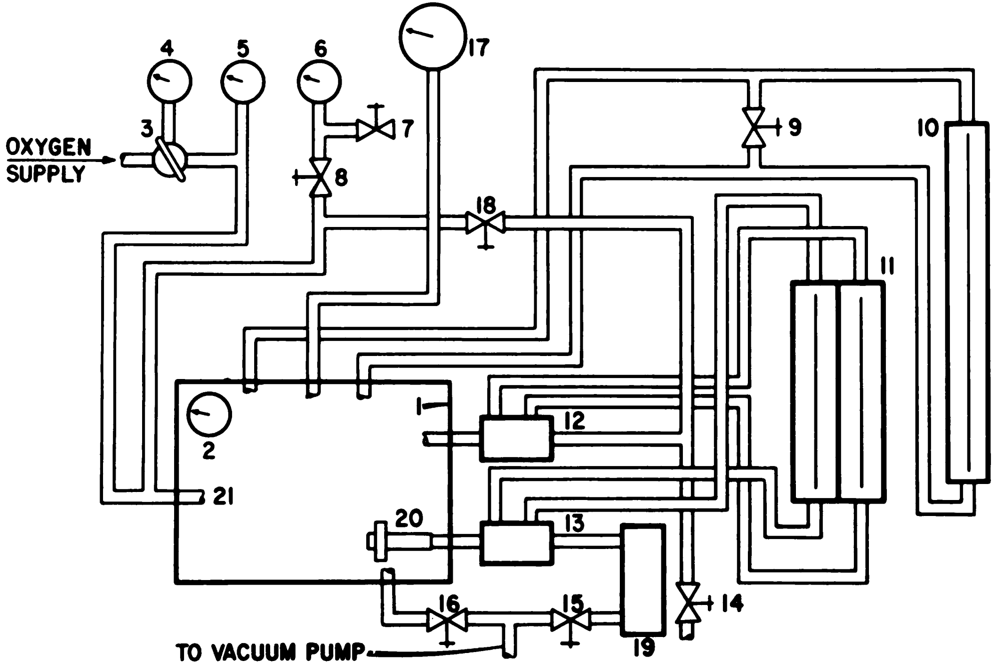


Figure 10-34.—Schematic of modified OTS-565 test stand.

Nomenclature for figure 10-34.

1. Altitude chamber.
2. Chamber altimeter (60,000 ft.).
3. Oxygen pressure reducer.
4. Gage, high-pressure (4,000 p.s.i.).
5. Gage, high-pressure (3,000 p.s.i.).
6. Gage, low-pressure (200 p.s.i.).
7. Pressure relief valve, Hoke, 560.
8. Oxygen gage low-pressure cutoff valve, Hoke, 304.
9. Valve, Hoke, P450.
10. Pressure-suction manometer.
11. Manometer (input and output Vol-O-Flo).
12. Input Vol-O-Flo element.
13. Output Vol-O-Flo element.
14. Inlet valve.
15. Outlet valve.
16. Bypass valve.
17. Altimeter (100,000 ft.).
18. Valve, Hoke, D336M.
19. Ballast tank.
20. Piezometer ring.
21. Oxygen inlet.

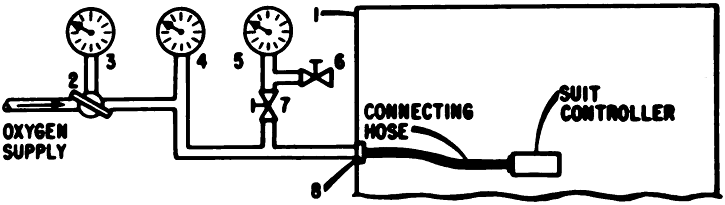


Figure 10-35.—Schematic of the test setup for the demand valve, controller case, and the exhaust valve leakage test.

1. Altitude chamber.
2. Oxygen pressure reducer.
3. Gage, high-pressure (4,000 p.s.i.)
4. Gage, high-pressure (3,000 p.s.i.)
5. Gage, low-pressure (200 p.s.i.)
6. Relief valve.
7. Oxygen gage low-pressure cutoff valve.
8. Oxygen inlet.

6. Hold this hose over the aneroid compartment relief port in such a manner that the hose will transfer the oxygen from the bleed port to the rotameter without leakage.

7. There shall be a flow of 100 to 150 cc./min. indicated on the rotameter.

8. At the end of the test close the oxygen supply valve.

9. Open the relief valve until the low-pressure gage reads zero.

10. Close the oxygen gage low-pressure cutoff valve and the pressure reducer.

SUIT CONTROLLER HOLD TEST.—The setup for this test is shown in figures 10-34 and 10-36. The procedure is as follows:

1. Connect the suit controller to the test chamber oxygen inlet, by means of the oxygen fitting.

2. Connect the suit exhaust air inlet to the inlet of piezometer ring. Make certain the piezometer ring is attached, as in the diagram, to the output Vol-O-Flo.

3. Connect (by means of a hose) the static pressure tap of the piezometer ring to the inlet of the chamber altimeter.

4. Open the oxygen supply valve.

5. Open the oxygen gage low-pressure cutoff valve.

6. Adjust the pressure reducer until 70 p.s.i. is indicated.

7. Start the vacuum pump.

8. Close the chamber with the cover glass.

9. Open the bypass valve to evacuate the chamber at the rate of about 10,000 ft./min.

10. Level the chamber at an altitude of 40,000 feet as indicated on the high-altitude altimeter. The inlet valve can be opened slightly if it is necessary to lower the chamber altitude when leveling at 40,000 feet.

11. When the high-altitude altimeter is stabilized at 40,000 feet, the chamber altimeter should indicate an altitude no lower than 34,500 feet nor higher than 36,500 feet.

12. If the chamber altimeter indicates the required altitude, close the inlet valve and open the bypass valve to evacuate the chamber to an altitude of 70,000 feet.

13. Stabilize the chamber altitude at 70,000 feet.

14. The chamber altimeter should indicate an altitude no lower than 34,500 feet nor higher than 36,500 feet.

15. At the end of the test, close the bypass valve and open the inlet valve to allow the chamber altitude to drop to ambient at the rate of 10,000 ft./min.

16. When the chamber altitude is at sea level, remove the cover glass and shut off the vacuum pump.

17. Close the inlet valve.

18. Close the oxygen supply valve.

19. Open the relief valve until the low-pressure gage reads zero.

20. Close the oxygen gage low-pressure cutoff valve and the pressure reducer.

TEST FOR CONTROLLER'S ABILITY TO COMPENSATE FOR SUIT LEAKAGE.—The setup for this test is shown in figures 10-34 and 10-36. The procedure is as follows:

1. Connect the suit controller to the chamber oxygen inlet.

2. Connect the suit exhaust air inlet to the inlet of piezometer ring. Make certain the piezometer ring is attached as in the diagram, to the output Vol-O-Flo.

3. Connect (by means of a hose) the static pressure tap of the piezometer ring to the inlet of the chamber altimeter.

4. Open the oxygen supply valve.

5. Open the oxygen gage low-pressure cutoff valve.

6. Adjust the pressure reducer until 70 p.s.i. is indicated.

7. Start the vacuum pump.

8. Close the chamber with the cover glass.

9. Open the bypass valve to evacuate the chamber at the rate of about 10,000 ft./min.

10. Stabilize the altitude of the chamber at 60,000 feet as indicated on the high-altitude altimeter. The inlet valve can be opened and adjusted to maintain the altitude of the chamber at 60,000 feet if necessary.

11. With the chamber stabilized at 60,000 feet, the altitude indicated on the chamber altimeter should be no lower than 34,500 nor higher than 36,500 feet. Note the altitude indicated.

12. Open the outlet valve until a flow of 60 l.p.m. is indicated on the output Vol-O-Flo manometer. (Actual l.p.m. is in reference to the altitude indicated on the chamber altimeter.)

13. When a flow of 60 l.p.m. is indicated, the altitude indicated on the chamber altimeter shall be noted.

14. The altitude on the chamber altimeter with a flow of 60 l.p.m. shall not be greater than 37,500 feet.

15. At the end of the test, close the outlet valve.

16. Close the bypass valve.

17. Open the inlet valve to allow the chamber altitude to drop at the rate of 10,000 ft./min.

18. When the chamber altitude is at sea level, remove the cover glass and shut off the vacuum pump.

19. Close the inlet valve.

20. Close the oxygen supply valve.

21. Open the relief valve until the low-pressure gage reads zero.

22. Close the oxygen gage low-pressure cutoff valve and the pressure reducer.

BREATHING REGULATOR.—The setup for this test is shown in figure 10-37. The procedure is as follows:

1. Clamp the test fixture to the face seal in the helmet.

2. Connect hose from the largest outlet (3/4 I.D.) of the fixture to the output Vol-O-Flo.

3. Connect hose from one of the smaller outlets of the fixture to the bottom of the pressure-suction manometer.

4. Block all other ports from the fixture.

5. Connect the breathing regulator oxygen inlet to the test stand oxygen inlet.

6. Open the oxygen supply valve.

7. Open the oxygen gage low-pressure cutoff valve.

8. Adjust the oxygen pressure by means of the pressure reducer to read 70 p.s.i.

9. Turn the breathing regulator button to ON with visor closed.

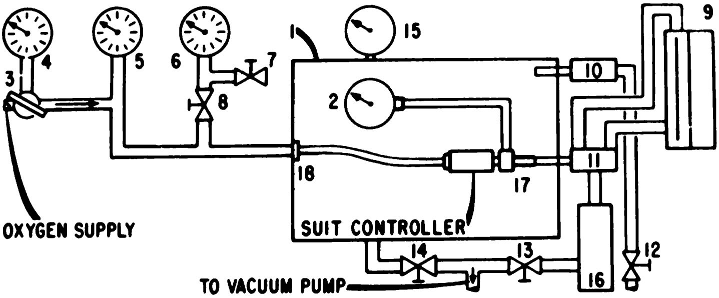


Figure 10-36.—Schematic of test setup for the suit controller hold test and the test for the controller's ability to compensate for suit leakage.

1. Altitude chamber.
2. Altimeter (60,000 ft.).
3. Oxygen pressure reducer.
4. Gage, 4,000 p.s.i.
5. Gage, 3,000 p.s.i.
6. Gage, 200 p.s.i.
7. Relief valve.
8. Oxygen gage LP cutoff.
9. Manometer (Vol-O-Flo).
10. Input Vol-O-Flo element.
11. Output Vol-O-Flo element.
12. Inlet valve.
13. Outlet valve.
14. Bypass valve.
15. Altimeter (high altitude).
16. Ballast tank.
17. Piezometer ring.
18. Oxygen inlet.

10. The pressure-suction manometer should read between 1/2 to 1-1/2 inches of water pressure.

11. Open the outlet valve (with pump on) until the output manometer indicates 5 l.p.m.

12. The pressure-suction manometer should indicate a pressure at least slightly above zero.

13. Close the outlet valve.

14. Slide regulator button to OFF position.

15. Close the oxygen supply valve.

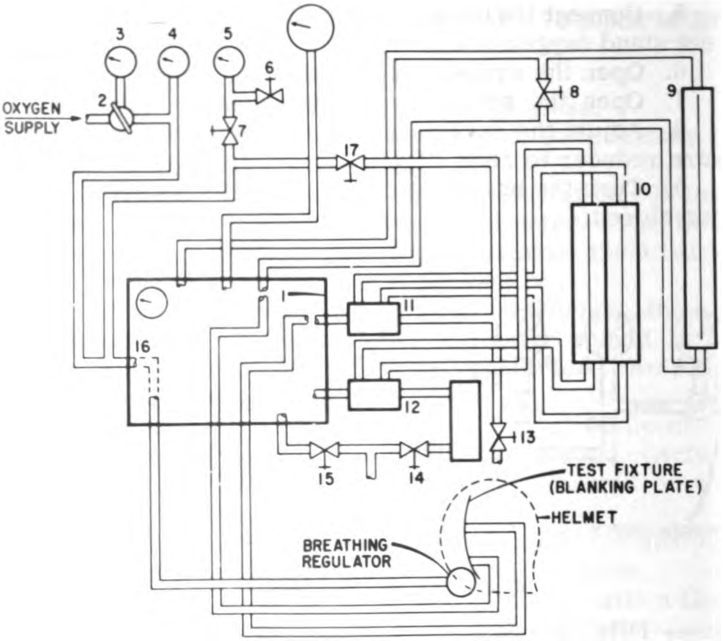


Figure 10-37.—Schematic of test setup for testing the CR-90 breathing regulator.

1. Altitude chamber.
2. Oxygen pressure reducer.
3. Gage, 4,000 p.s.i.
4. Gage, 3,000 p.s.i.
5. Gage, 200 p.s.i.
6. Relief valve.
7. Oxygen gage LP cutoff.
8. Valve, Hoke.
9. Pressure-suction manometer.
10. Manometer (Vol-O-Flo).
11. Input Vol-O-Flo element.
12. Output Vol-O-Flo element.
13. Inlet valve.
14. Outlet valve.
15. Bypass valve.
16. Oxygen inlet.

16. Open the relief valve until the low-pressure gage reads zero.

17. Close the oxygen gage low-pressure cutoff valve and the pressure reducer.

18. Shut off the vacuum pump.

EXHALATION VALVE.—The setup for this test is shown in figure 10-38. The procedure is as follows:

1. Clamp the test fixture to the face seal in helmet.
2. Connect hose from the largest outlet (3/4 I.D.) of the fixture to the input Vol-O-Flo.
3. Connect hose from one of the smaller outlets of the fixture in the bottom of the pressure-suction manometer.
4. Block all other ports from the fixture.
5. Connect the breathing regulator oxygen inlet to the test stand oxygen inlet.
6. Open the oxygen supply valve.
7. Open the oxygen gage low-pressure cutoff valve.
8. Adjust the oxygen pressure by means of the pressure reducer to read 70 p.s.i.
9. Turn the breathing regulator button to ON with visor closed.
10. The pressure-suction manometer should read between 1/2 to 1-1/2 inches of water pressure.
11. Check the exhalation valve for leakage. There should be none.
12. Close the pressure reducer and open the relief valve (keep regulator button in ON position).
13. When zero pressure is indicated on the low-pressure gage, disconnect hose from oxygen inlet.
14. Block the oxygen inlet.
15. Open the pressure reducer until 10 p.s.i. is indicated.
16. Open valve (17, fig. 10-38) until 90 l.p.m. is indicated on the input manometer.
17. The pressure indicated on the pressure-suction manometer should be no greater than 2.5 inches of water.
18. Close valve (17).
19. Slide regulator button to OFF position.
20. Close the oxygen supply valve.
21. Open the relief valve until the low-pressure gage reads zero.
22. Close the oxygen gage low-pressure cutoff valve and the pressure reducer.

EMERGENCY REDUCER.—The setup for this test is shown in figure 10-39. The procedure is as follows:

1. Connect hose from the output Vol-O-Flo to valve (7, fig. 10-39).
2. Connect with hose (150 p.s.i. test pressure) from this valve to a 0 to 100 p.s.i. gage (8) and from this gage to the emergency cylinder reducer.

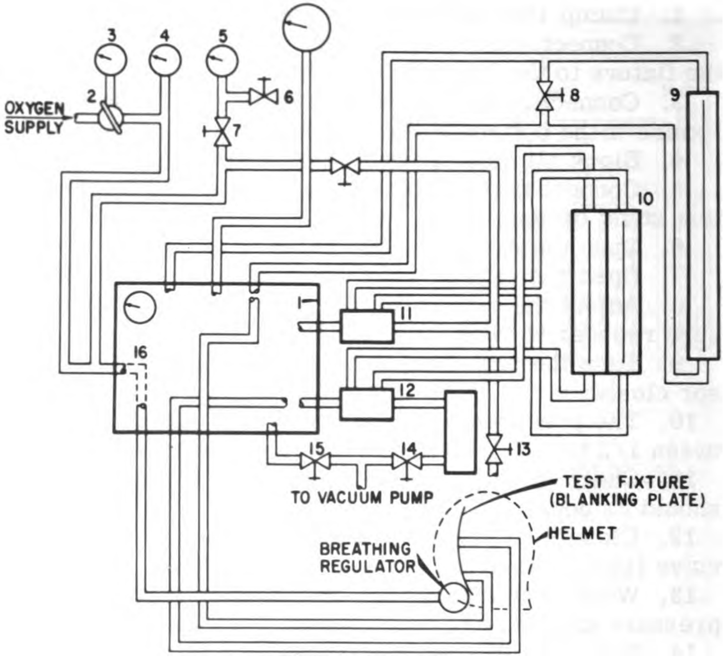


Figure 10-38.—Schematic of test setup for testing the exhalation valve.

1. Altitude chamber.
2. Oxygen pressure reducer.
3. Gage, 4,000 p.s.i.
4. Gage, 3,000 p.s.i.
5. Gage, 200 p.s.i.
6. Relief valve.
7. Oxygen gage LP cutoff.
8. Valve, Hoke, P450.
9. Pressure-suction manometer.
10. Manometer (Vol-O-Flo).
11. Input Vol-O-Flo element.
12. Output Vol-O-Flo element.
13. Inlet valve.
14. Outlet valve.
15. Bypass valve.
16. Oxygen inlet.
17. Valve, Hoke, D336M.

3. Open the output and bypass valves.

4. Cylinder gage should read 1,800 p.s.i.

5. Make certain valve (7) is closed.

6. Actuate reducer.

7. The 0 to 100 p.s.i. gage should read between 40 and 60 p.s.i.

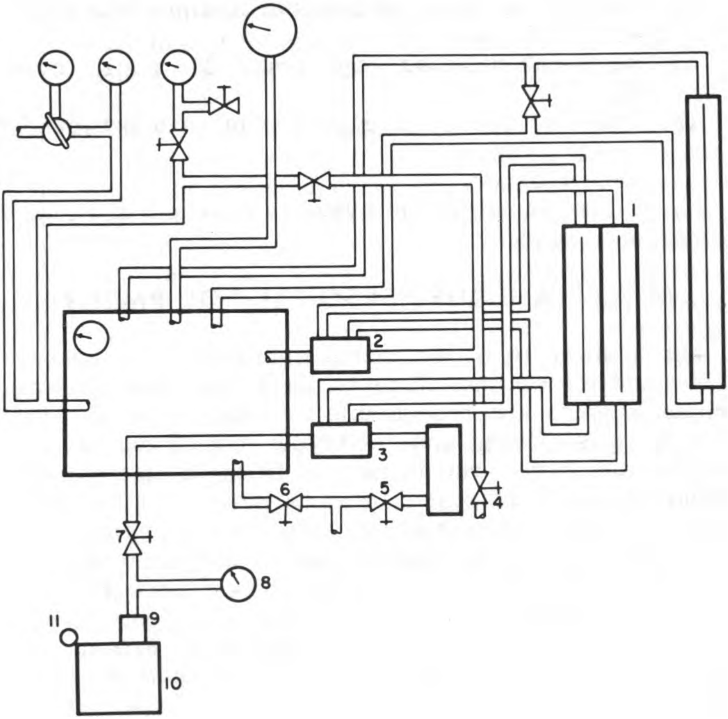


Figure 10-39.—Schematic of test setup for testing the emergency reducer.

1. Manometer (Vol-O-Flo).
2. Input Vol-O-Flo element.
3. Output Vol-O-Flo element.
4. Inlet valve.
5. Outlet valve.
6. Bypass valve.
7. Shutoff valve.
8. Gage, 0 to 100 p.s.i.
9. Emergency reducer.
10. Emergency cylinder.
11. Cylinder gage.

8. Open valve (7) until output manometer indicates 140 l.p.m.

9. The 0 to 100 p.s.i. gage should read between 40 and 60 p.s.i.

10. Keep valve open until cylinder gage is down to 250 p.s.i.

11. The 0 to 100 p.s.i. gage should continue to read between 40 and 60 p.s.i.
12. When the cylinder gage reads 250 p.s.i., close valve (7).
13. The 0 to 100 p.s.i. gage should read between 40 and 60 p.s.i.
14. Lock reducer.
15. Close the output and bypass valves and disconnect emergency reducer.

MISCELLANEOUS PERSONAL EQUIPMENT

In addition to fitting and maintaining full pressure suits and instructing others in their use, leading Parachute Riggers are responsible for fitting and adjusting anti-g suits, fitting and modifying oxygen masks, and instructing lower rated men in fitting helmets, anti-exposure suits, integrated torso harness suits, and other types of flight and protective clothing and equipment.

Flight clothing is indexed under Federal Stock Class 84, and allowances authorized for aircraft squadrons are contained in Section H of the Bureau of Aeronautics *Allowance List*. As a leading Parachute Rigger, you must be familiar with the dozens of items authorized for use by your outfit and be fully qualified to fit, adjust, repair, and make authorized modifications to these items, as well as instruct others in their use.

Anti-g Suits

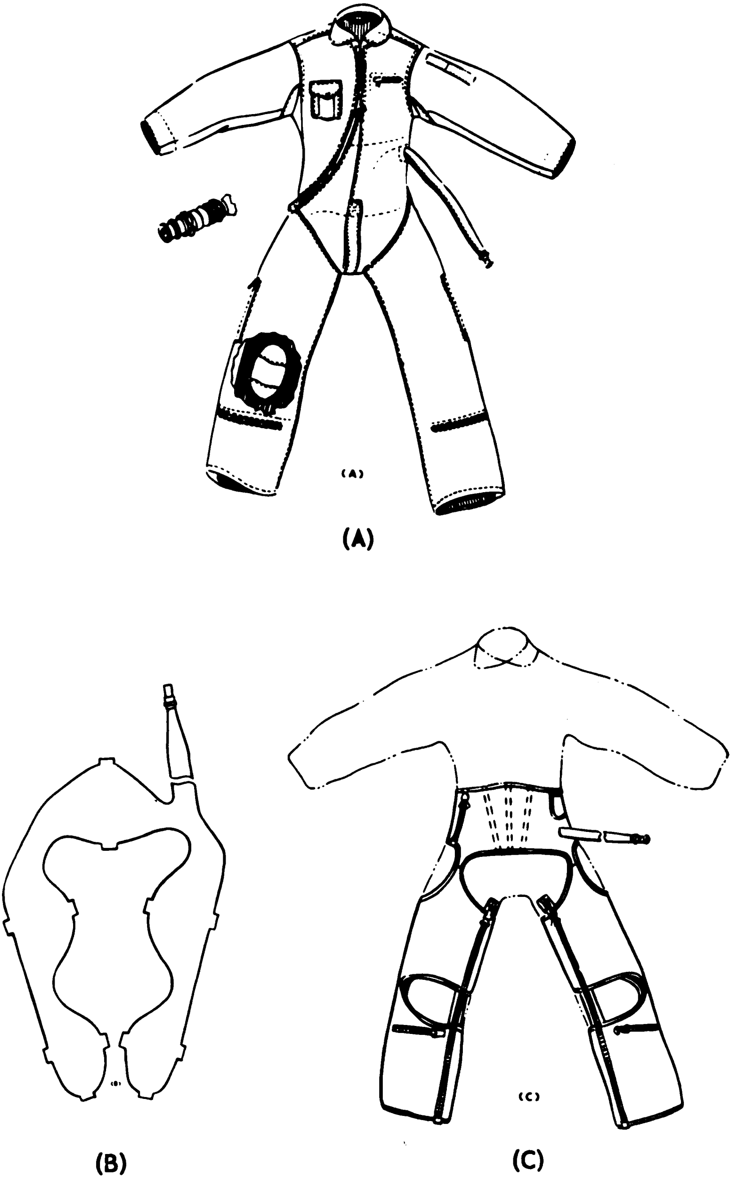
Anti-g equipment is currently installed in high-performance aircraft to counteract the effects of prolonged acceleration on the pilot. The ill effects of such acceleration range from excessive fatigue and decreased alertness to blackout and unconsciousness.

EFFECTS OF ACCELERATION.—It is generally stated in relation to anti-g suits, that for each unit corresponding to the pull exerted by the earth's gravitational field, the force of inertia in acceleration is proportional to the square of the velocity and inversely proportional to the radius of the turn. For example, at 5 g's the pilot's body is exposed to a force of inertia which increases its weight and that of its components 5 times.

Greyout and blackout are physiological anoxic states directly related to the diminished blood volume reaching the eye and higher cerebral centers during and following periods of high acceleration. During these periods, the blood tends to pool in the blood vessels of the legs and abdomen, thus diminishing the amount of blood returning to the heart, and the cardiac output is therefore reduced. Thus, greyout and blackout with disturbances in the state of consciousness are merely symptoms of successive steps of anoxia of the brain. These symptoms are directly proportional to the amount of g's, the reduced cranial blood supply, and the length of time these factors are acting.

Without anti-g coveralls, the average pilot can withstand 4.5 to 5.5 g's without losing vision or blacking out. With anti-g coveralls, the average pilot is capable of withstanding 6.0 to 7.0 g's. This protection is available only for sustained accelerations of 4 to 5 seconds or longer in maneuvers other than snap maneuvers. It is emphasized that the anti-g equipment does not offer protection in snap maneuvers where 10 to 12 g's can be applied in approximately 1 second.

FITTING THE ANTI-G SUIT.—Anti-g coveralls are furnished in the following types: Type Z-2, or full garment, and Type Z-3, or cutaway garment. (See fig. 10-40.) The Z-2, which is available in 11 sizes, resembles a standard summer flying suit; while the Z-3 is a skeleton type and is available in 4 sizes. Both types have 5 interconnected bladders which are attached to the air pressure source with a single quick-disconnect hose. These coveralls provide a range of from 1.0 to 2.0 g protection against blackout, depending on the type of coveralls, variations in the tightness of fit, and whether the HIGH or LOW setting on the anti-g pressure regulating valve is used. Another feature of the anti-g valve is the pushbutton at the top which may be operated manually to test the anti-g equipment on the ground or in level flight. Prior to each flight, the Parachute Rigger should make certain the pilot depresses this button to check the operation of the system. This feature also makes possible the inflating of the coveralls in long flights from time to time in order to relieve venous congestion of the legs and stiffness and tension of the body by a massaging effect of the inflating bladders.



(A)

(B) (C)

Figure 10-40.—Anti-g suits. (A) Z-2 coverall type; (B) Internal bladder arrangement; (C) Z-3 cutaway type.

In the initial fitting of the anti-g coverall, the decisions revolve around the correct choice of fit which is that of selecting the proper size. However, everyone's measurements do not conform with standard size requirements. The coverall should fit snugly, especially at the waist. The Flight Surgeon, aided by a Parachute Rigger, is responsible for fitting and instructing personnel. If there are any doubts about the fit, the pilot should sit in a simulated position as in the aircraft, and inflate the coveralls orally. The bladders should compress the waist, calves, and thighs firmly and evenly. If difficulty is encountered in properly fitting the coverall legs, zipper inserts, which are available to increase the leg sizes, may be used in the Z-2 garment. If the pilot has difficulty in getting coveralls with legs small enough, you, the Parachute Rigger may have to tailor the legs. This is accomplished by taking in all the slack to insure a snug fit the full length of the legs. After marking this slack material with a suitable tailor's crayon, the legs are finished by sewing with a flat fell seam. Extreme care must be used when sewing on anti-g suits to prevent the needle from penetrating any one of the bladders. The Z-3 anti-g cutaway garment may be adjusted by the lacings provided on the garment.

USE OF THE EQUIPMENT.—All pilots of aircraft in which anti-g equipment is installed should wear the coverall type to become familiar with its functioning and advantages. It is particularly important that it be worn in the early stages of operational and gunnery training in fleet-type aircraft. It is on these flights that the pilot may miscalculate and pull excessive g's for a sufficient time to cause blackout or unconsciousness.

It is emphasized that anti-g equipment is effective in reducing fatigue under sub-blackout accelerations and especially so at high altitudes where factors of mild anoxia, lowered pressures, and acceleration may be cumulative. While high accelerations may not be encountered at high altitudes, the coveralls are still of considerable value for their antifatigue characteristics. Where higher accelerations are encountered, such as combat flight at lower altitudes, the anti-g equipment is even more important. Therefore, to improve combat preparedness and efficiency, the Parachute Rigger must make certain that all pilots concerned are thoroughly indoctrinated in the use of anti-g equipment.

The coveralls are not intended to take the place of the life jacket, but will act as accessory flotation gear to provide extra flotation. Each coverall is equipped with an oral inflation valve which can be inserted into the end of the coverall inflation tube for oral inflation. In the event of a force-down at sea, instruct the pilot to unzip both legs by jerking upward on the quick release zipper fastenings on the upper thighs. Then, the plug is taken out of the left breast pocket and inserted into the disconnect. Next, the oral valve is unscrewed, and the wearer orally inflates the coveralls.

TEST AND MAINTENANCE.—To inspect for leaks, tears, or weakened fabric, the suit should be inflated to 5 p.s.i. The pressure must not fall below 4 p.s.i. in 30 seconds.

The coveralls should be laundered in lukewarm water, washed by hand, and never scrubbed or ironed. When not worn, the suit should be hung on a coathanger in a well-ventilated room.

A-13A Oxygen Mask

The A-13A pressure breathing oxygen mask consists of a facepiece, inhalation valves, pressure compensating exhalation valve, microphone port, harness assembly, and breathing tube assembly. Cleaning and maintenance of the components and installation of the ANB-M-1C microphone are duties of lower rated Parachute Riggers. However, first class and chief Parachute Riggers are responsible for the proper fitting and adjusting the mask to the individual wearer.

The A-13A pressure breathing mask is supplied in 4 sizes; small, medium, large, and extra large. The correct size will hug the face comfortably, and the inside flap will fit tightly around the nose and mouth area. The A-13A oxygen mask, adjusted to the helmet liner, is shown in figure 10-41. This oxygen mask is classified as personal equipment. Oxygen masks are issued through regular supply channels under the supervision of the Supply Officer, through the Flight Clothing Issue Section of the Supply Department. After drawing new flight gear, a pilot will take this equipment to the parachute loft for assembly and fitting, especially when items like the hard-shelled helmet, liner, microphone, and mask are included in his list. The headphones used in the helmet liner are installed by electronics personnel.

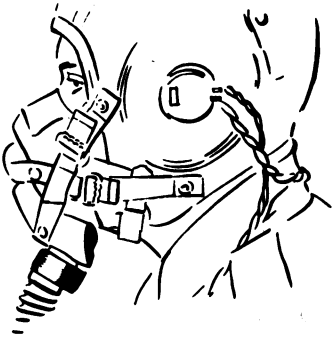


Figure 10-41.—A-13A oxygen mask adjusted to helmet liner.

When the pilot or airman has selected the size mask best suited to his face, the Parachute Rigger will have little or no difficulty in aiding him to adjust the mask properly; that is, obtaining a secure and comfortable fit. Occasionally, however, every detail of the fitting process is not successful. The individual concerned in the problem may have sharp features or the bridge of his nose and the indentation between the chin and lips may be so confined that none of the 4 mask sizes available can be adjusted to a leak-proof fit. The problem of successfully fitting the nonconforming features of an individual is not entirely hopeless. The inner lip of the mask can be built up using a thin layer of specially developed soft spong rubber laminate (Seal, laminar, stock number R-83-AMEL-503), cemented into place. Ordinary sponge rubber cannot be used. This special sponge rubber laminate seal contains thousands of tiny air sacs which will expand at altitude, thereby assuring a more leaktight fit.

APPLICATION OF THE LAMINATE SEAL.—For application of the laminate seal, the following instructions will apply:

1. Roughen the sealing surface of the inner lip of the mask with emery paper.
2. Apply an even, medium weight coat of cement to the rough side of the laminate seal and to the surface of the mask just roughened.
3. Line up and determine the top and bottom centerlines of the inner lip and the laminate in preparation for adhering the pieces together.

4. When the cement is tacky, gently lay the upper nose section of the laminate seal in place, lining up with the centerlines concerned. While doing this, take care not to make contact with the lower portion until the proper overall alignment has been assured.

5. After aligning the laminate seal with the inner lip surface of the mask, lay it in place, pressing tightly together. Allow the contacting surfaces to dry at least an hour. If the laminate seal is wrinkled or not positioned correctly, strip it from the facepiece, cleaning the surface with solvent (Ethyl Acetate, ASO 51-E-338) before installing a new seal.

6. Masks fitted with this laminated seal require added care in handling, especially when they are cleaned periodically with a soft soap solution to remove particles of dirt and dried perspiration.

To install a new metal yoke harness assembly, the mask tube must be removed and the yoke slipped on over the breathing tube extension of the mask. After this, the tube is secured back in place. The metal yoke and harness combination was designed to replace the old style harness which was suspended higher on the mask through the use of molded rubber lugs. By suspending the mask from a lower position and adding the laminate seal to the inner lip of the facepiece, a better and more comfortable fit for a greater number of individuals was made possible.

New production masks are being fitted with the laminate seals and metal yoke assemblies. Masks which have been modified in the field will eventually be replaced by the production models (either the entire mask assembly or just the facepiece in accordance with conditions) as soon as they are made available.

The replaced masks will not be turned in to supply, but will be retained by squadrons or stations as spares, and will be modified when yokes and seals become available. All necessary repairing and component replacement of old or new mask assemblies and components will be performed by the organization using the equipment or other authorized activities, in accordance with local instructions.

FITTING THE A-13A OXYGEN MASK.—The normal adjustment steps involved in fitting the A-13A pressure breathing oxygen mask are as follows:

1. Place the mask over the pilot's nose and mouth. While holding the mask in position, check its fit by stopping off the bailout connector inlet. Have the pilot try inhaling gently to see if the mask will cling to the contours of the face, making further inhalation impossible. This is merely a preliminary check to see that the size selected is suitable. If the size selected is not suitable, inhalation will most likely be made possible by a poor seal around the bridge of the nose. When the preliminary fitting proves successful, go on to the next step.

2. Have the pilot place the under-helmet liner on the head, adjusting and tightening the chin strap. Attach the mask harness to the liner and adjust to a comfortable but secure fit. The mask cheek flaps should be under the liner against the face. Cheek flaps may be trimmed if the mask proves to be uncomfortable under the liner. In some cases it might be advisable to completely trim off the cheek flaps up to the inner lip portion. Make a second preliminary check for mask leakage as described in step 1.

3. With both inhalation valves and the compensated exhalation valve installed in the mask assembly, place a clean smooth rubber stopper firmly in the oxygen inlet end of the end connector assembly, attached to the end of the mask hose, and perform the following tests:

To test the inhalation valves, hold the mask close to the pilot's face, but not sealed to the face. While supporting the connector (at the end of the mask hose) steadily in the hand, have him inhale deeply. After inhaling, press the mask to the face, and have him exhale forcibly and completely through the exhalation valve. If the inhalation valves are not closing properly, the exhalation valve will not open. If the inhalation valves are seated properly, the exhalation action will be smooth with a minimum of resistance noted.

To test the exhalation valve, place an obstruction (rubber band or equivalent) under the rubber flapper of one of the inhalation valves in a manner to prevent the flapper from forming a seal. Repeat the testing procedure described for testing the inhalation valves. If the exhalation valve is functioning properly, it will not open when the subject inhales, and exhalation through the valve will not be possible.

To test for mask hose and fitting leakage, remove the stopper, affix the mask assembly to the face with the helmet in place and, using the mask suspension harness, adjust the straps for a snug comfortable leaktight fit. Again, block off the inlet port of the mask hose connector assembly, and have the pilot inhale sharply and deeply, holding or attempting the inhalation action as long as possible. If there is no inboard leakage, immediate signs of suffocation will be evident.

4. As a preflight inspection to leak test the mask in the aircraft, check the mask in the following manner:

Adjust the mask securely in place and connect it to the regulator breathing extension tube or console. With the oxygen system turned on, place the regulator safety pressure selector lever in the ON position. Induce a severe outboard mask leakage by placing two fingers under the mask sealing surface and observe the flow indicator which should remain in the FLOW position. If there is no mask leakage, the flow indicator will remain in the NO FLOW position. Leakage will cause the flow indicator to assume an actuated position. Adjust the suspension straps until the leakage is stopped, if possible. Return the safety pressure selector lever to the OFF position.

DO NOT USE A MASK THAT LEAKS. This is the final groundleak test that can be given a mask when a decompression chamber and medical examiners are not available. A mockup oxygen system, installed in the shop or loft, can be used to make a final groundleak check. If this cannot be done due to a critical supply condition, the test must be carried out on an aircraft system.

Instruct all pilots to check the mask fit during flight by actuating the safety pressure, and taking a deep breath and holding it. Note position of the oxygen flow indicator. If the flow indicator opens, excessive leakage is indicated. Tighten the mask straps until the flow indicator closes. Because of the characteristics of flow indicators that have not been modified in accordance with *Accessories Bulletin* No. 4-56, this test cannot be conducted at pressure breathing altitudes. In this case, the outward flow of oxygen into the eyes from a leaking mask is readily detectable.

A-14 Oxygen Mask

The A-14 oxygen mask should be used with a demand type system not having safety pressure features. It is designed to supply adequate oxygen at altitudes up to 37,500 feet. With precaution, adequate oxygen is supplied for short durations at 40,000 feet.

The A-14 mask assembly consists of a mask body which completely covers the nose and mouth. It is fitted with an exhalation valve of the rubber flutter type. The adjustable straps of the suspension harness shown in figure 10-42 are arranged differently in comparison with the pressure type mask. Since this mask was not designed to hold pressure, there are no inhalation valves installed in the open ports. The exhalation valve is very simple in construction and is designed to prevent air from entering the mask upon inhalation.

There are no inner lips in the A-14 mask. The exhalation valve, seated in the bottom of the mask, permits exhaled air to flow out of the mask through two ports, one on each side of the mask exterior. The A-14 oxygen mask may be replaced with the A-13A pressure breathing mask on any demand type regulator; however, substitution of the A-14 mask in place of the A-13A is not permissible.

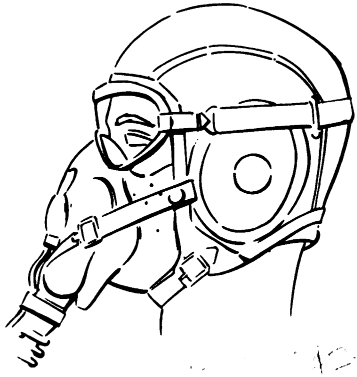


Figure 10-42.—A-14 oxygen mask, left side view showing position of the straps.

FITTING THE A-14 OXYGEN MASK.—The normal fitting procedure for the A-14 oxygen mask follows:

1. Select the size mask (small, medium, large, or extra large) which corresponds to the facial characteristics of the individual to be fitted.
2. To effect a proper and comfortable integration of oxygen mask and helmet, the assistance of a Parachute

Rigger is needed. Have the individual put on his helmet. Have the wearer hold the mask so that it fits snugly to the face (fig. 10-43 (A)). Hold adjustable straps on the left side of the mask up to the helmet so that the snap fasteners are in the most suitable position. Mark clearly the location for the helmet studs by inserting a pencil point through the center hole of the sockets (fig. 10-43 (B)).

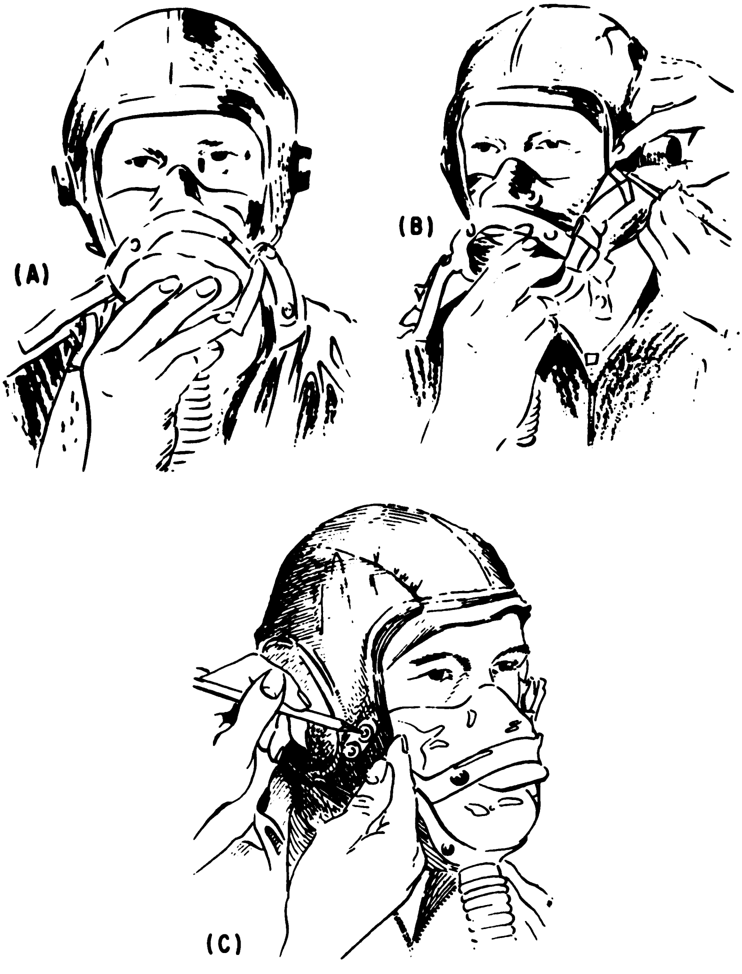


Figure 10-43.—Fitting the A-14 oxygen mask.

To position the helmet studs on the right side, engage the buckle loop of the mask suspension strap with the helmet sidehook and follow the above procedure for determining and marking the positions of the right side helmet studs (fig. 10-43 (C)).

3. When the helmet stud positions have been marked, remove the helmet and mask and attach studs as follows: For summer helmets, three helmet webbing straps, with studs attached, are provided. These straps with two studs each are sewed to the left side of the helmet in accordance with the markings. The four-stud piece of webbing is sewed on the right side. The webbing straps are necessary for reinforcement of the studs. The four-stud arrangement makes it possible to shift the position of the right side adjustment strap containing the loop.

4. The studs may be individually positioned on summer type helmets as well as winter type helmets, but reinforcement is necessary to prevent tearing of the lightweight helmet. Therefore, apply the stud so that a reinforcing tape will completely enfold the base of the stud with the face end of the material fastened beneath it. In addition to acting as a reinforcement the tape also prevents contact of the face with the metal stud base. Thus the possibility of frostbite during flights below zero is eliminated.

5. For winter type helmets, or for any helmet to which the webbing straps cannot be conveniently sewed, individual stud and eyelets will have to be attached. Using a revolving belt punch, make the number of necessary holes at the located points through the helmet, and set the fasteners. To prevent metal contact with the face, a piece of fabric cut to size may be cemented directly over each eyelet base.

6. Snap the helmet sidehook securely to the right side helmet studs. Have the wearer don the helmet and attach the mask. Tighten the suspension straps until the mask is snug and comfortable with equal tension all around. Cut off the excess length, if any, of suspension straps and secure the loose ends with metal clinches.

7. Test the mask for leakage by placing the thumb over the disconnect at the end of the mask tube and have the pilot inhale gently. If there is no apparent leakage,

the mask will adhere to the face and further inhalation will be impossible.

APH-5 Protective Helmet

The APH-5 protective helmet (fig. 10-44) is furnished in two sizes, medium and large. The complete unit consists of an outer shell, energy-attenuating liner, sizing pads (sets of 3 thick and 3 thin), an integrated visor, earcup assemblies (containing the earphones), communication cord, oxygen mask mounting tabs, and adjustable chinstrap. In addition, an envelope containing 4 shims and two 1/2-inch screws for horizontal adjustment of the earcup assemblies, and a sizing instrument to be utilized in fitting the helmet properly are issued with each helmet.

The outer shell provides force-distribution and penetration-resisting properties. It is molded from glass fabric and a polyester resin. The liners are provided to absorb or dissipate impact energy and thereby prevent skull fracture and/or brain injury. There are 3 sections (molded from cellular polystyrene sheet) cemented to the inside of the shell to fit the contour of the inside shell.

The sizing pads permit fitting of the helmet to an individual's head contour with the proper balance between stability and comfort. They are supplied in three basic configurations—back, crown, and front, also in two basic thicknesses—thin and thick. BuAer *Aviation Clothing and Survival Equipment Bulletin* No. 3-57A, authorizing modification of the sizing pads, must be complied with on all helmets still in service.

The integrated visor provides protection from sun glare, windblast, dust, foreign particles, and flash fires. It has excellent optical properties and is protected from damage when in the UP position by a housing molded from a glass fabric and polyester resin. Two colors of visors are available for use in the helmet assembly, clear and neutral grey. The neutral grey visor, which is darker at the top than at the bottom to afford maximum protection from sun glare and facilitate reading of the instrument panel, is currently supplied in three shades.

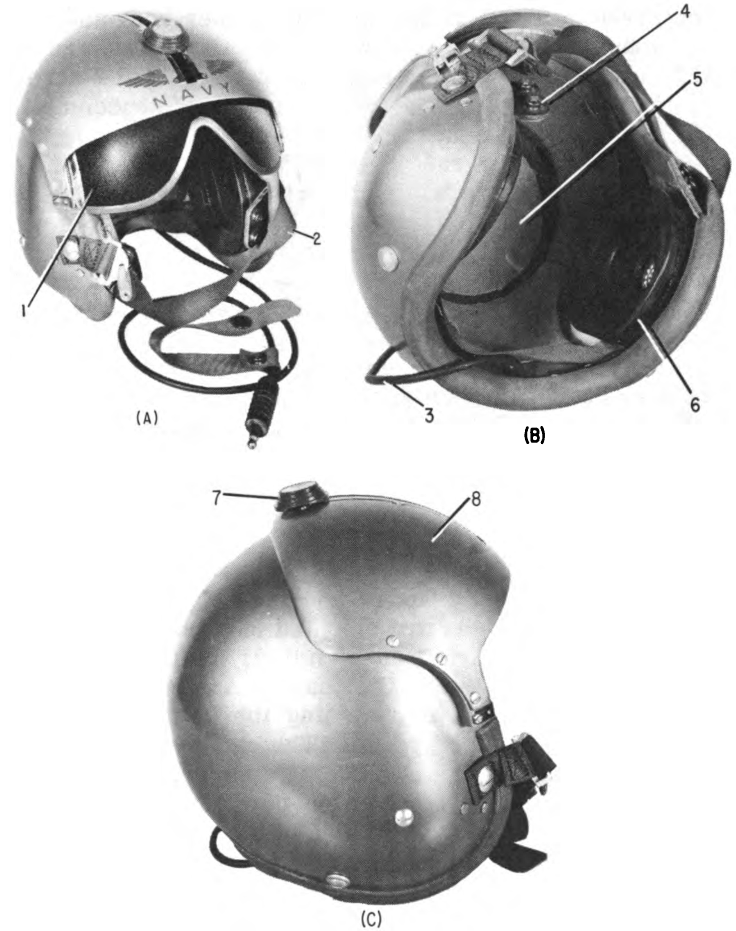


Figure 10-44.—APH-5 protective helmet.

1. Integrated visor.
2. Chin strap.
3. Communication cord.
4. Oxygen mask mounting tabs.
5. Sizing pads.
6. Earcup assemblies.
7. Visor adjustment button.
8. Visor housing.

The earcup assemblies contain the earphones and improve radio reception by providing good attenuation of outside noise. Each assembly consists of a phone housing of cellular polystyrene and an ear cushion assembly composed of a soft neoprene foam rubber body and a diisocyonate foam face cushion. If the earcup assemblies are loose and need adjustment, the 4 shims and 2 screws contained in the envelope should be utilized to accomplish the lateral adjustment. Proper fit of the earcup is necessary for proper radio reception. The type H-87A/U earphones are installed in the cellular polystyrene earcup of the ear cushion assembly. Each earphone is connected to the two wires leading out of each side of the molded junction block of the communication cord.

The communication cord is designed to provide electrical connections between the earphones and the aircraft radio facilities. The molded junction block connecting the four earphone leads to the cord is located in the back left center of the helmet. The communication cord jack incorporates a transformer and connects to the extension cord leading from the jack box in the aircraft.

The oxygen mask mounting tabs are to provide a means of securing the oxygen mask to the face and to assist in achieving a seal around the face in the oral-nasal area. The tabs are mounted in such a manner and position so as to permit an even distribution of pressure over the sealing area of the mask. Another function of the tabs is to assist in retaining the helmet and mask during bailout at high speeds. The chinstrap is also designed to retain the helmet during emergency escapes at speeds in excess of 500 miles per hour. The BuAer *Aviation Clothing and Survival Equipment Bulletin* which covers the installation of the nape strap must be complied with on all helmets not equipped with nape straps.

Hardman oxygen mask retention kits are provided for installation with the APH-5 helmet to improve chances of retention of helmet and mask during ejection. BuAer *Aviation Clothing and Survival Equipment Bulletin* No. 17-58 covers the installation instructions for these kits. Chin cup straps with microphone and Hardman fittings are provided for use with the helmet when oxygen mask is not used.

The Hardman oxygen mask retention kit is shown in figure 10-45 (A); the kit fitted to the A-13A oxygen mask is illustrated in figure 10-45 (B).

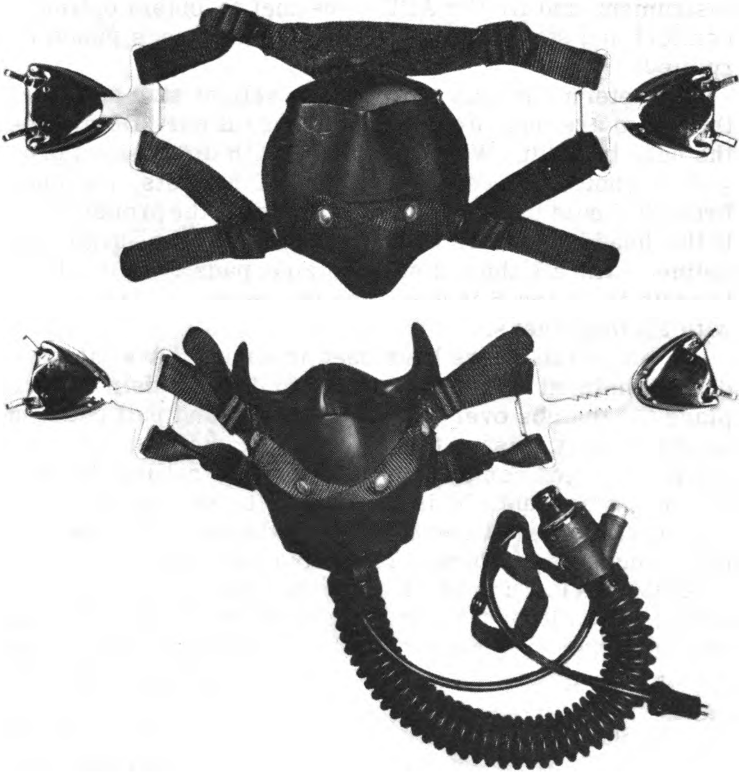


Figure 10-45.—(A) Hardman oxygen mask retention kit; (B) retention kit attached to A-13A oxygen mask.

BOOM-TYPE MICROPHONE ATTACHMENT.—The installation of a boom-type microphone should be accomplished as follows:

Pre-position the boom mike assembly on the side of the helmet. Swing the boom through a full arc to determine the optimum point. Then, scribe the intended position of the bracket, drill holes accordingly, and attach. The position will vary with the face shape and personal preference. Boom-type microphones are not provided with the helmet assembly and must be ordered individually.

FITTING TECHNIQUES.—To properly use the sizing instrument and fit the APH-5 helmet to obtain optimum comfort and stability, the following instructions should be applied:

1. Determine head length. The helmet size and liner thickness are indicated on the horizontal bar. Determine the head breadth. When the head length dimensions provide a choice between two sizes of helmets, the head breadth should be a factor in determining the proper size. If the head breadth is over 6 inches, use the large size helmet with all thick liners (sizing pads). If the head breadth is under 6 inches, use the medium size helmet with all thin liners.

2. After the liners have been inserted, have the pilot don the helmet. The proper way to don the helmet is to place the thumbs over the ear cushions, and pull outward on the helmet; insert the forehead in the area between the thumbs and complete the donning by rolling the helmet backward until it is positioned to his satisfaction.

If the pilot is not comfortable or the helmet lacks stability, make the following suggested revisions:

COMFORT.—If a thick liner is used in the area affected, substitute a liner of lesser thickness. If the pressure point remains, choose next larger size and use the thick liners in the unaffected area and thin liners in the affected area.

STABILITY.—To obtain maximum stability, a snug fit is required. It is possible that stability has been sacrificed for comfort in relieving the pressure points. Proper stability can be determined by vigorously shaking the head. Keep in mind that the pilot must be the judge in determining the correct balance between comfort and stability of the helmet.

CLEANING THE VISOR.—The visor is cleaned by washing with mild soap and water, using a clean rag. If the visor is still soiled or has minor scratches, use acrylic plastic polish, Specification MIL-C-18767. As a final step, apply wax to preserve the surface.

After fitting has been accomplished, the unused sizing pads, shims, and sizing instruments should be returned to the local supply officer for reissue. In addition, clear visors that are not being used should be returned to supply for reissue.

QUIZ

1. The visor on the full pressure suit headpiece is locked in the closed position by
    - a. the secondary shell
    - b. the inflatable seal
    - c. the clip lock
    - d. none of the above

2. The oxygen regulator used with the full pressure suit is located on the
    - a. oxygen mask
    - b. rubber face seal
    - c. shell of the headpiece
    - d. soft aluminum frame

3. The inner garment of the full pressure suit is
    - a. air retaining
    - b. pressure restraining
    - c. neither air retaining nor pressure restraining
    - d. both air retaining and pressure restraining

4. The full pressure suit bailout unit will operate
    - a. any time the bailout pin has been pulled
    - b. only if the pin is pulled at the time of bailout
    - c. when aircraft oxygen pressure on top of the diaphragm falls below minimum and the pin has been pulled
    - d. when aircraft oxygen pressure under the diaphragm falls below minimum and the pin has been pulled

5. Under normal conditions, with the cockpit adequately pressurized, the full pressure suit
    - a. remains in an unpressurized state
    - b. is pressurized by the aircraft pressurization system
    - c. is pressurized by the aircraft oxygen system
    - d. is pressurized by the bailout oxygen system

6. The Mk IV full pressure suit has four suit port fittings, located in the upper torso below the armpits
    - a. True
    - b. False

7. The outer garment of the full pressure suit is
    - a. air retaining
    - b. pressure restraining
    - c. both air retaining and pressure restraining
    - d. neither air retaining nor pressure restraining

8. The respiratory section of the full pressure suit is separated from the pressurization section by the
   a. antisuffocation valve
   b. neck bearing
   c. helmet
   d. face seal
9. The A-14 oxygen mask may be replaced with the A-13A pressure breathing mask on any demand type regulator; however, substitution of the A-14 mask in place of the A-13A is not permissible.
   a. True
   b. False
10. The purpose of the full pressure suit controller is to
   a. deliver 100 percent oxygen
   b. deliver 100 percent air
   c. control the pressure in the suit
   d. control the pressure in the respiratory section
11. At any time the cockpit pressure is lost, the
   a. aneroid bleed port will be blocked
   b. aneroid will expand
   c. pressure will be maintained in the control section
   d. all the above will take place
12. The full pressure suit oxygen regulator performs how many functions?
   a. 1
   b. 2
   c. 3
   d. 4
13. During the full pressure suit leakage test, the leakage rate must not exceed______l.p.m.
   a. 10
   b. 20
   c. 30
   d. 50
14. In order to compensate for suit leakage, the suit controller must deliver oxygen at a minimum of____l.p.m.
   a. 50
   b. 60
   c. 70
   d. 80
15. It is necessary to maintain the positive pressure in the pressure suit headpiece respiratory section in order to
   a. assure 100 percent oxygen to the user
   b. assure normal and/or 100 percent oxygen to the user
   c. assure pressure on the face at all times
   d. seal the face seal

16. When performing the full pressure suit bailout unit delivery pressure test, after having pulled the pin and read the pressure gage,
    a. set 140 l.p.m. flow with the high capacity valve and take the delivery pressure reading
    b. check the relief valve
    c. insert the pin in the reducer before continuing
    d. check the unit for leakage

17. The suit leak tester may be used to test full pressure suit leakage
    a. with a man in the suit but not pressurized
    b. with a man in the suit with the suit pressurized
    c. when the suit is empty but pressurized to 2.0 p.s.i.
    d. when the suit is empty but pressurized to 3.5 to 4.0 p.s.i.

18. The suit leakage flowmeter will indicate actual leakage when the suit is pressurized and holding steady at______l.p.m.
    a. 1
    b. 2
    c. 3
    d. 4

19. If the entrance zipper does not operate freely,
    a. replace the zipper
    b. lubricate with DC-33
    c. lubricate with DC-7
    d. replace the slider only

20. Approximately what percentage of the oxygen is delivered through the defogging tube into the respiratory section of the headpiece?
    a. 70
    b. 80
    c. 90
    d. 100

21. Deflation of the visor is automatically accomplished by placing the GR-90 ON-OFF button in the OFF position.
    a. True
    b. False

22. The last component of the full pressure suit to be put on by the wearer is the
    a. gloves
    b. headpiece
    c. boots
    d. torso

23. On occasions the full pressure suit should be pressurized between 3.5 and 4.0 p.s.i. to determine
    a. excessive ballooning
    b. the characteristics of the pressure relief valve
    c. suit leakage
    d. excessive headpiece rise

24. It is not necessary for the PR to assist the pilot in donning the flotation garment.
    a. True
    b. False

CHAPTER 11

SEWING MACHINE REPAIR

The Parachute Rigger is called upon to perform an enormous amount of repair work on parachutes and survival equipment in all types of maintenance activities. Although lower rated men perform much of this work, the task of maintaining the sewing machines in top running condition falls on the senior Parachute Riggers. Qualified machine operators may assist in this work under supervision; however, determining the causes of malfunctions, making major adjustments, and replacing of parts are the responsibility of the first class and chief.

CLASS 111 SEWING MACHINES

The most widely used sewing machine in the parachute loft is the Class 111 series. Machines in this class are designated as 111 W 150, 111 W 151, 111 W 153, and 111 W 155. A brief description of each of these machines is included in this section, pointing out their differences and specific uses. Maintenance procedures presented in the following section are those recommended specifically for the 111 W 151 and the 111 W 155; however, in most cases they will apply to other models as well.

Sewing Machine 111 W 150

The 111 W 150 sewing machine is a high-speed, single-needle, lockstitch, compound feed machine employing a belt driven rotary hook with a vertical axis. The machine has ball bearings on the upper and lower shafts and in the hook saddle. It is designed for stitching medium weight fabrics such as the kinds used in flight clothing, all nylon cloth sewing, and lightweight canvas up to 12 ounces.

The maximum speed recommended for this machine is 3,500 stitches per minute. The machine should be run slower than the maximum speed until the parts which are in moving contact have become glazed by their action on each other. When the machine is in operation, the balance wheel turns over toward the operator.

Needles for the 111 W 150 machine are of class and variety 135 x 7, sizes 7 to 24. The size needle to use for a given job should be determined by the size of the thread, which must pass freely through the eye of the needle. If rough or uneven thread is used, or if it passes through the eye of the needle with difficulty, either the needle or thread will be broken.

Orders for needles must specify the quantity desired, the size number, and the class and variety numbers separated by an x.

The following is an example of an order: 100 No. 14, 135 x 7 needles.

Sewing Machine 111 W 151

The Model 111 W 151 sewing machine is also a single-needle, lockstitch, rotary hook textile machine, for high-speed straight seaming of medium-heavy materials. In parachute maintenance and repair, this machine is used primarily for general repair sewing.

The 111 W 151 sewing machine differs from other models of class 111 in that it has a single presser foot instead of the alternating presser foot. Hence, the back of the machine arm casting for the 111 W 151 does not have the lifting rockshaft mechanism that is located above the knee lifter lever on other machines of this class. The 111 W 151 has a maximum speed of 3,500 stitches per minute.

The major assemblies for feeding material and stitching seams derive their power from the arm shaft, which is connected to the balance wheel. Proper operation, maintenance, and repair of the 111 W 151 sewing machine are based upon an understanding of the line of power and the interrelation of all components.

Timing Sequence for 111 W 151

The first step in timing the 111 W 151 is to set the feed driving eccentric on zero stitches per inch (s.p.i.). Set the needle bar. With the needle bar in its lowest position (needle bar crank in the horizontal position, the rounded portion on the top and driving stud at the bottom) the connecting link will be vertical. Set the needle bar with the upper timing mark just visible at the base of the needle bar rock frame and tighten needle bar pinch screw. The needle bar is then properly set.

The next step is to time the arm shaft with the hook drive shaft. With the connection belt removed rotate the balance wheel toward the operator until the thread take-up lever is at its highest point, then align the arrow on the hook drive shaft timing plate, and replace the connection belt. Rotate the balance wheel and check. The next step is to center the feeding action. For this step the feed driving eccentric must be set on 0 s.p.i. With the needle entering the feed dog, center the needle in the hole in the feed dog with a distance of 17/32 inch between the needle bar and the presser bar. In centering the feeding action the following is the sequence that must be followed: When the needle is properly centered in the feed dog, and the space between the needle bar and presser bar is right, tighten the feed driving crank pinch screw. Next, tighten the feed driving rock shaft crank pinch screw; making sure that the crank is flush with the end of the feed driving rock shaft and parallel with the bed. Next, tighten the needle bar rock frame rock shaft crank pinch screw in the back of the uprise. The shank of the presser foot may be used for measuring the space.

The next step is to set the sewing hook to or from the needle. This is done by moving the hook saddle left or right as necessary, the hook should pass the needle as close as possible without touching. When this is done retighten hook saddle screws. Next, set the sewing hook with the needle. With the needle bar on the upstroke the lower timing mark on the needle bar should be just visible at the base of the needle bar rock frame. Set the point of the sewing hook in the center of the needle 1/16 inch above the eye. To advance the sewing hook, move the hook drive gear to the right; and to retard, move the hook drive gear to the left.

NOTE: The spline screw should be the first screw in the pinion gear and the second screw in the hook drive gear. The hook drive gear must be centered in relation to the sewing hook shaft at the bottom of the hook saddle.

Sewing Machine 111 W 153

The 111 W 153 sewing machine is similar to the 111 W 150 sewing machine except that it is designed for heavier work and is equipped with alternating presser feet for more positive feeding action. The positive feeding motion is brought about by the compound action of the alternating pressers. The rear presser holds the material down while the needle and forward presser are not in contact with the material; when the needle and forward presser come in contact with the material, the rear presser rises until the feeding motion of the needle, forward presser, and feed dog is completed.

This machine is not adaptable to light fabric work, as the feeding action of the alternating pressers puckers and damages lightweight fabrics. The maximum recommended speed of the 111 W 153 sewing machine is 2,900 stitches per minute.

Sewing Machine 111 W 155

The Model 111 W 155 sewing machine is equipped with a vertical-axis, rotating hook to carry the bobbin. No back-stitching or darning can be done with this machine. The front or vibrating foot, the needle and the feed dog move in unison. Together they move the cloth away from the operator with each completed stitch. The back presser foot, or vibrating presser holds the fabric while the vibrating presser foot rises and moves forward.

The working space on this machine is 10-1/2 inches. The maximum operating speed is 3,500 stitches per minute. This machine can be regulated to sew from 3-1/2 to 32 stitches per inch. The proper needles to use for this machine are of class 135, variety 17, and the size of the needles run from 14 to 23. The motor used on the 111 W 155 sewing machine is a Singer electric transmitter, series S59, 210-230 volts, 1/3-horsepower, 60-cycle.

Maintenance and Repairs

Major sewing machine repairs consist primarily of replacing damaged or worn parts. The instructions given in this section cover the near complete disassembly of the 111 W 155 machine. However, since disassembly means complete resetting and retiming, the Parachute Rigger is cautioned not to strip the machine beyond those steps necessary for the replacement of the defective part. In stripping assemblies, be careful to note which screws are set into grooves in the various shafts since the machine cannot be retimed if setscrews are not properly positioned during reassembly. An understanding of the line of power shown in figure 11-1 will aid in performing necessary repairs.

INSPECTION AND CLEANING OF NEW EQUIPMENT.—If the equipment is crated when received, be careful to remove the crating, bracings, and packing material without damaging the parts. Watch for and save any special instructions, parts lists, tools, spare parts, and parts which may have shaken loose from the machine during shipment.

When a machine is received, and before it is installed or used, it must be thoroughly cleaned. All grease, grit, and corrosion preventives must be removed. Dry-cleaning solvent or diesel fuel oil may be used for cleaning. Small parts may be washed in the solvent; large parts should be sponged off with a rag dipped in the cleaning agent. Gasoline should not be used; the lead compounds in gasoline are poisonous and corrosive.

The installation of the machine received should be accomplished by following the instructions packed with each new sewing machine.

Examine the nameplate on the motor to see whether the motor is made to operate on the current provided. Before belting the motor to the machine, lubricate and test it. When the motor switch is turned on, the motor should turn in a direction which will cause the balance wheel to turn towards the operator. If a motor turns in

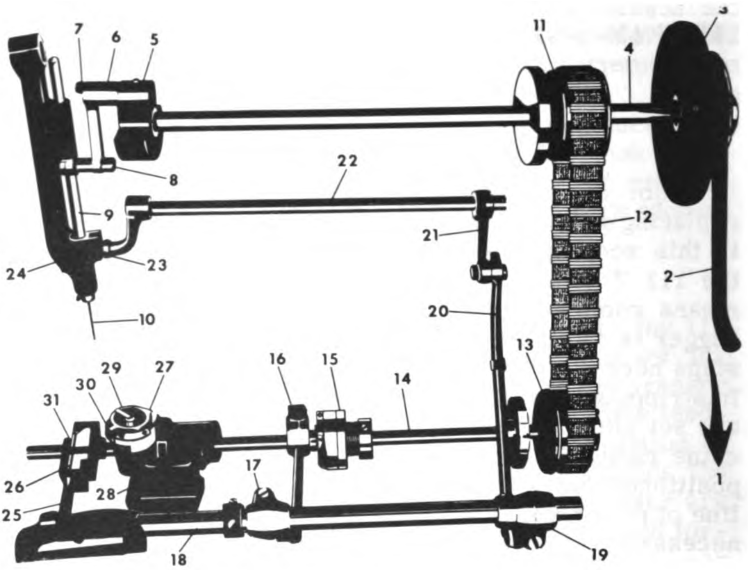


Figure 11-1.—Line of power transmission.

LINE OF POWER TO THE NEEDLE

1. 1/3 hp electric motor.
2. Round leather belt/V belt.
3. Balance wheel.
4. Arm shaft.
5. Needle bar crank.
6. Needle bar driving stud.
7. Needle bar connecting link.
8. Needle bar connecting stud.
9. Needle bar.
10. Needle.

LINE OF POWER TO THE NEEDLE BAR ROCK FRAME

4. Arm shaft.
11. Arm shaft pulley.
12. Arm shaft connecting belt.
13. Safety clutch pulley.
14. Hook driving shaft.
15. Feed driving eccentric.
16. Feed driving connection.
17. Feed driving crank.
18. Feed driving rock shaft.
19. Feed driving rock shaft crank.
20. Needle bar rock frame rock shaft crank connection.
21. Needle bar rock frame rock shaft crank.
22. Needle bar rock frame rock shaft.
23. Needle bar rock frame slide block.
24. Needle bar rock frame.

the wrong direction, the leads in the motor switch box should be disconnected and interchanged.

Before the machine is run with the motor, it should be tested by hand-turning the balance wheel to find out whether all parts of the machine operate freely and in correct time. If the balance wheel is hard to turn with no sewing material under the needle, further tests should be made to discover what part is binding.

ADJUSTMENTS AND REPAIRS.—If wear and damage cannot be corrected by proper adjustments, the Parachute Rigger will replace parts of the assemblies in accordance with current instructions. When new parts are installed, make certain that each new part is well lubricated and moves freely and without binding. A new part should never be forced or driven into place. The operation of a newly installed part should be tested by hand-turning the sewing machine. If the part binds, it may get hot and warp when the machine is put into operation. If a newly installed part fits too tightly, it should be dressed down carefully to make a snug fit. For dressing down iron or steel parts, emery cloth of a suitable grade may be used. However, emery cloth should not be used on brass or other soft metal bearings, because the abrasive material may become embedded in the metal and score the bearing surfaces of shafts.

Nomenclature for Figure 11-1—Continued.

LINE OF POWER TO THE FEED DOG

4. Arm Shaft.
11. Arm shaft pulley.
12. Arm shaft connecting belt.
13. Safety clutch pulley.
14. Hook driving shaft.
15. Feed driving eccentric.
16. Feed driving eccentric connection.
17. Feed driving crank.
18. Feed driving rock shaft.
25. Feed bar.
26. Feed dog.

LINE OF POWER TO THE SEWING HOOK

4. Arm shaft.
11. Arm shaft pulley.
12. Arm shaft connecting belt.
13. Safety clutch pulley.
14. Hook driving shaft.
27. Hook driving gear. (Located under bobbin assembly; cannot be seen in the illustration.)
28. Hook driving pinion.
29. Sewing hook shaft. (Cannot be seen in illustration.)
30. Sewing hook.
31. Lifting cam. (Cannot be seen in illustration.)

STITCH REGULATOR.—The 111 W 155 sewing machine can be set to sew from 3-1/2 to 32 stitches per inch, as determined by the following operations:

Hold down the plunger in the bed of the machine until you feel it drop into the slot in the feed driving eccentric cam. (See fig. 11-2.) Note that there are two plungers in the bed of the machine. For changing the length of the stitch, hold down the plunger closest to the needle bar. The other plunger is for use in re-engaging the safety clutch, as explained later. After you feel the plunger drop into the notch, hold it in the notch while rotating the balance wheel backward to shorten the stitch, or forward to lengthen the stitch.

The stitch indicator disc, which can be seen through the hole (5), normally turns with the balance wheel. The number seen through the hole while the plunger is pressed into the slot of the feed driving eccentric flange indicates the length of stitch for which the machine is set. To test the accuracy of the indicator, sew an inch, count the

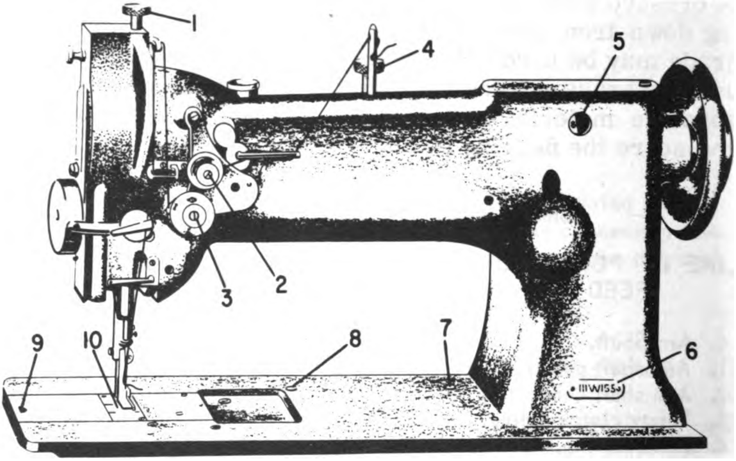


Figure 11-2.—Model 111 W 155 sewing machine.

1. Vibrating presser bar thumbscrew.
2. Tension thumb nut.
3. Thread controller stud thumb nut.
4. Pressure bar spring regulating screw.
5. Stitch indicator disc view hole.
6. Model number.
7. Hook driving shaft lock ratchet plunger.
8. Feed regulating (plunger).
9. Bed slide.
10. Throat plate.

number of stitches being sewed to the inch, and compare the counted number with the number revealed through the stitch indicator hole.

NOTE: The stitch indicator disc does not control the number of stitches per inch, it only indicates how the feed driving eccentric is set. All feeding action originates and is controlled by the feed driving eccentric.

If the stitch indicator disc is not accurately set, it should be adjusted as follows:

With a pencil or tailor's crayon, make two parallel lines 1 inch apart on a scrap of fabric. Sew a line of stitches across both lines and at right angles to them. Count the stitches per inch and adjust the stitch regulator until the machine is sewing 8 stitches per inch.

Open the cover plate on top of the machine arm, and turn the balance wheel until the setscrew hole in the edge of the indicator disc comes into view. Run a screwdriver into this hole, as indicated in figure 11-3, and loosen the

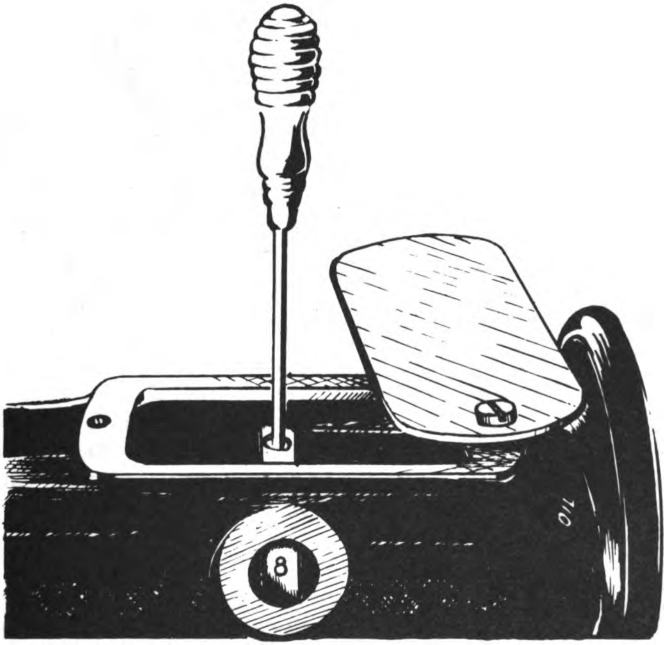


Figure 11-3.—Adjusting the stitch indicator.

screw so that the indicator disc does not turn with the balance wheel.

Hold down the plunger and turn the balance wheel until the plunger drops into the notch feed driving eccentric flange. Do not turn the balance wheel after the plunger engages the notch.

Without disturbing the balance wheel and with the plunger still engaging the notch, turn the stitch indicator dial until the figure "8" appears through the hole. Tighten the setscrew in the indicator disc. The machine will then be set to sew 8 stitches to the inch, and the indicator disc should indicate accurately.

THREAD TENSIONS.—The bobbin thread tension is regulated by the spring on the outside of the bobbin case. Do not take the bobbin case out of the hook assembly to change the tension. Use a small screwdriver to turn the setscrew in the center of the spring (near the thread slot in the bobbin case). To increase the tension, turn the setscrew to the right.

The tension on the needle thread is controlled by the thumb nut in front of the tension discs. (See fig. 11-2.) To change the needle thread tension, lower the presser foot, causing the tension discs to close, and turn the thumb nut as necessary to put the correct tension on the thread. To increase the tension, turn the thumb nut to the right. Keep in mind that the tension on the needle thread can be regulated only when the presser foot is down.

SAFETY CLUTCH.—One setscrew in the hook driving pinion and one in the hook driving gear are splined. This splining of the screws is to prevent the gears and pinions from slipping around on their shafts and throwing the hook out of time with the needle. This also prevents damage to the machine when an unusual strain is thrown upon the hook or needle mechanism during operation. When an undue strain is thrown upon the machine, the safety clutch locking lever slips out of its notch and slides around on the collar.

To re-engage the safety clutch after it has been operated automatically press down the plunger nearest the uprise so that it engages in the lock ratchet on the hook driving shaft, and turn the balance wheel backward. The plunger will hold the hook driving shaft until the safety

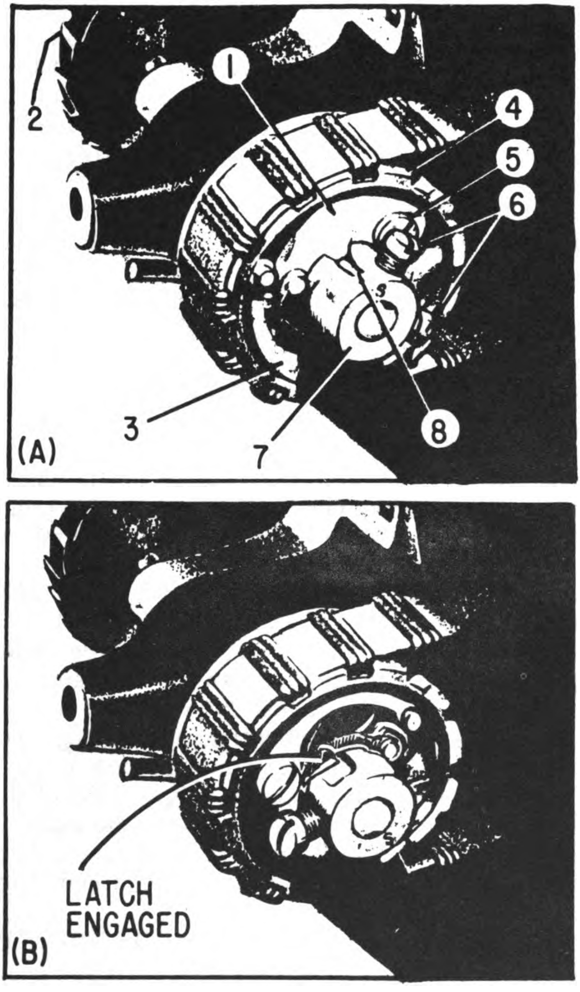


Figure 11-4.—Safety clutch showing (A) locking lever in its operating position, and (B) throw-in latch in its operating position.

1. Safety clutch locking lever.
2. Hook driving shaft lock ratchet.
3. Safety clutch locking lever spring.
4. Safety clutch pulley.
5. Safety clutch locking lever hinge screw.
6. Safety clutch hook driving shaft position collar setscrews.
7. Safety clutch hook driving shaft position collar.
8. Notch in the position collar.

clutch locking lever turns around the collar and drops into the original notch. This operation will re-engage the clutch without disturbing the timing of the hook. Release the plunger, and turn the balance wheel forward to sew.

SETTING TIMING ARROWS.—When the thread take-up lever is at its highest point, the arrow stamped on the timing collar of the hook driving shaft will point to the arrow stamped on the timing plate attached to the underside of the bed. (See fig. 11-5 (A).) When the machine is so set, the arm shaft and the hook driving shaft are properly timed.

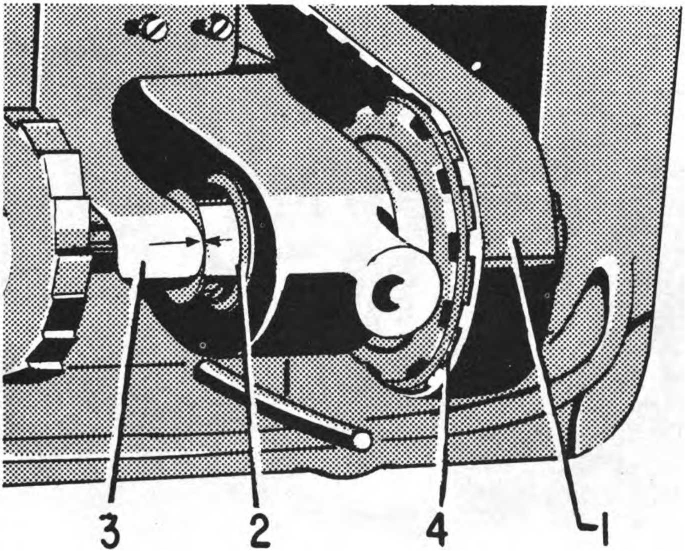
If the thread take-up lever is not at its highest point when the timing arrows are matched, the procedure for setting the machine is as follows:

Remove the arm shaft connection belt from the safety clutch pulley. Turn the balance wheel forward until the take-up lever reaches its highest point.

Rotate the safety clutch pulley with your fingers until the two arrows are matched. Keeping the take-up lever at its highest point and with the arrows matched, replace the arm shaft connection belt.

ADJUSTING THE RELATIVE HEIGHT OF LIFT OF THE VIBRATING AND LIFTING PRESSERS.—The amount of lift of the vibrating and lifting presser feet should be regulated according to the thickness of the material being sewn. The feet should lift just high enough to clear the material. As a rule, the vibrating and lifting pressers should lift an equal height, but some grades of work may require that they lift an unequal height. To change the relative lift of the presser feet, loosen the screw, item 2, figure 11-5 (B) at the back of the machine. Move the presser bar upward or downward as required, then securely tighten the screw.

ADJUSTING THE HEIGHT OF LIFT OF THE VIBRATING AND LIFTING PRESSERS ON MACHINE 111 W 155.—When centering the feeding action on the 111 W 155 the distance between the presser bars should be 21/64 inch. The 111 W 155 has two adjustment points on the alternating pressers, which have a total height of 3/8 inch. To change the height of lift of the presser feet, loosen the setscrew, item 1, figure 11-5 (B) in the feed lifting eccentric. Turn the balance wheel forward until the adjusting screw is accessible. The adjusting screw



(A)

Figure 11-5 (A).—Timing arrows.

1. Arm shaft connection belt.
2. Arrow on arm shaft connection belt timing collar.
3. Arrow on arm shaft connection belt timing plate.
4. Safety clutch pulley.

is not visible in figure 11-5 (B), but will be located approximately in the same position as the setscrew when the balance wheel is turned forward. To increase the amount of lift, turn the adjusting screw counterclockwise. To decrease the amount of lift, turn the adjusting screw clockwise. Then turn the balance wheel forward and retighten the setscrew.

TIMING THE SEWING HOOK WITH THE NEEDLE.—With the needle bar on the upstroke (3/32 inch above its lowest point), the point of the sewing hook must be in the center of the needle 1/16 inch above the eye of the needle.

If the needle bar does not have timing marks, turn the balance wheel forward until the needle bar has descended to its lowest position. Set the point of the needle even with the bottom of the feed dogs, rotate the balance wheel toward the operator until the needle bar has risen 3/32 inch, then set the sewing hook with the needle.

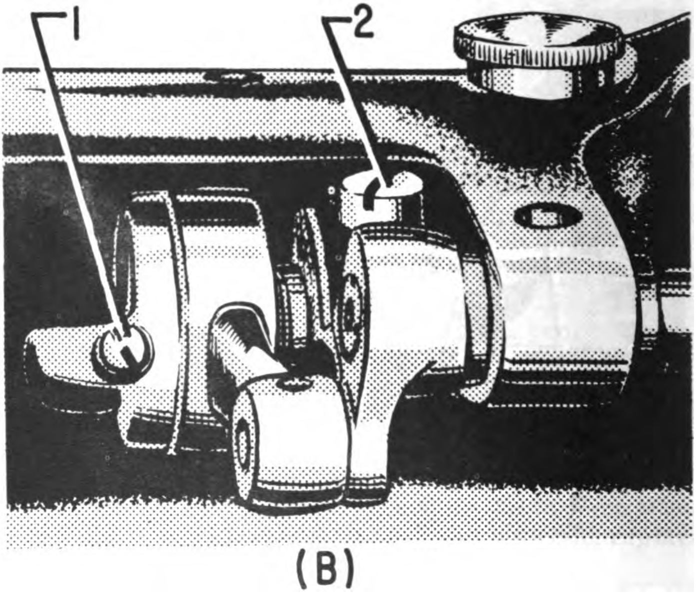


Figure 11-5 (B).—Adjusting the relative height and the height of lift of the vibrating and lifting pressers on machine 111 W 155.

1. Setscrew for adjusting the height of lift.
2. Setscrew for adjusting the relative height of alternating pressers.

If the needle bar does have timing marks, rotate the balance wheel forward until the needle bar is at its lowest position. Set the needle bar with the upper timing mark just visible at the base of the needle bar rock frame. Rotate the balance wheel forward until the needle bar has risen 3/32 inch (the distance to the lower timing mark just visible at the base of the needle bar rock frame). Set the point of the sewing hook in the center of the needle 1/16 inch above the eye.

To test for the correct timing of the needle, see that the thread take-up lever is at its highest point, that the timing arrows are matched, and that the hook crosses the center of the needle 1/16 inch above the eye on the upstroke. If the test is not satisfactory, or if the sewing hook is not picking up the thread, the machine should be timed in accordance with the procedures just given.

To set the sewing hook with the needle loosen the two screws in the hub of the hook driving gear (fig.11-6). Be

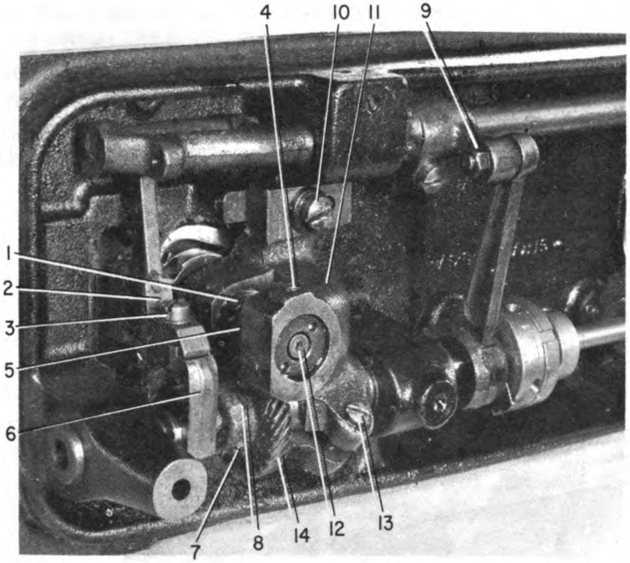


Figure 11-6.—Hook saddle driving gear and driving pinion.

1. Hook driving pinion.
2. Feed bar.
3. Feed lifting cam fork screw.
4. Hook driving pinion setscrew.
5. Hook driving pinion position screw.
6. Feed lifting cam fork.
7. Hook driving gear position screw.
8. Hook driving gear setscrew.
9. Feed driving connection hinge screw nut.
10. Hook saddle screw.
11. Hook saddle complete.
12. Bottom of hook shaft.
13. Hook saddle pinch screw.
14. Hook driving gear.

careful to keep the spot or spline screw in the slot cut into the driving shaft. Tap the hook driving gear along the shaft. If the hook is too slow, tap the gear to the right; if the hook is too fast, tap the gear to the left.

When the hook crosses the needle at a point 1/16 inch above the eye of the needle, securely tighten the two screws in the hub of the gear. Be certain that the position screw is in the slot in the shaft. Make certain that the timing arrows mentioned are matched when the hook is correctly timed.

RAISING AND LOWERING NEEDLE BAR.—Before attempting to raise or lower the needle bar, see that the needle is set correctly and as far up in the needle clamp as it will go. Set the feed eccentric to indicate 0 stitches.

Remove the faceplate, and take off the throat plate so the needle and hook can be seen.

Loosen the needle bar connecting the stud pinch screw, and raise or lower the needle as required. When the needle rises 3/32 inch from its lowest position, the point of the hook should be crossing the center of the needle at a point 1/16 inch above the eye.

Procedure for setting the marked needle bar follows:

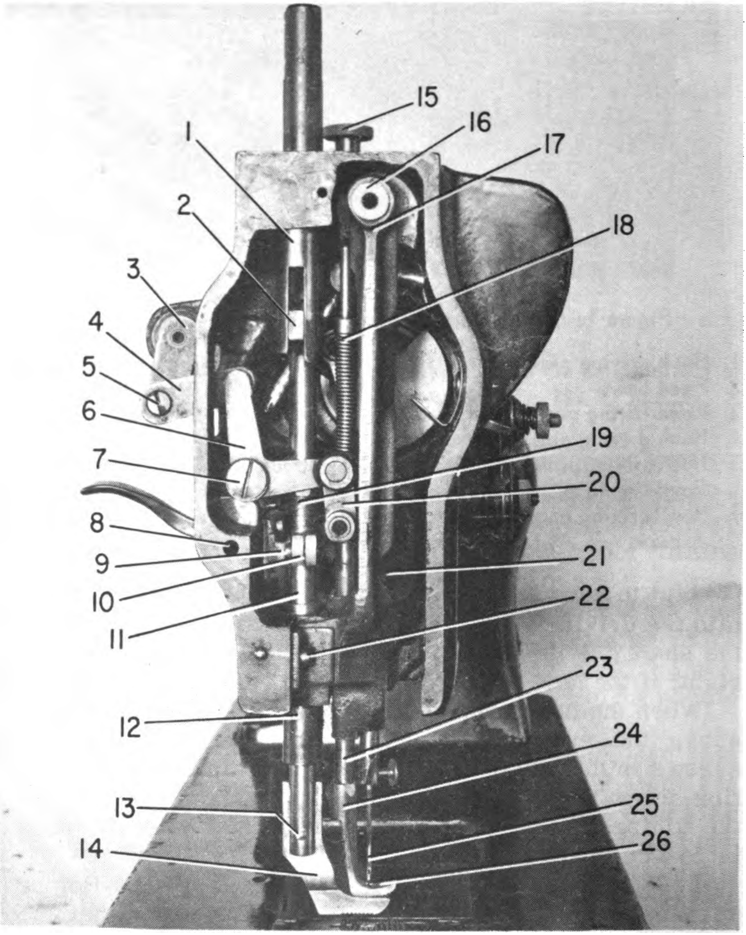


Figure 11-7.—Face assemblies installed.

Needle bars which have been installed by the factory have 2 lines across the bar about 2 inches above the lower end. When the needle bar (fig. 11-7) is at its lowest position, the upper mark should be just visible at the end of the needle bar rock frame. If a marked needle bar must be raised or lowered, loosen the needle bar connecting stud pinch screw, and raise or lower the bar until the upper mark is just visible at the bottom of the needle bar rock frame when the bar is at its lowest position. Then retighten the screw.

If the hook is out of time after changing the height of the needle bar, follow the timing instructions previously given.

SETTING SEWING HOOK TO OR FROM NEEDLE.— The point of the hook should pass as close to the needle as possible without touching it. If the hook is too far from the needle, it will divide and cut the strands of the needle thread. If the point of the hook strikes the needle, it will be blunted or otherwise damaged.

The procedure for setting the hook to or from the needle follows:

Turn the balance wheel forward until the point of the hook stands opposite the center of the needle. (See fig. 11-8.) Loosen the two screws which hold the hook saddle.

Nomenclature for Figure 11-7.

1. Presser bar position guide.
2. Presser bar position guide lever.
3. Lifting rockshaft.
4. Lifting bell crank link.
5. Lifting bell crank link screw stud.
6. Lifting bell crank.
7. Lifting bell crank cap screw.
8. Hole for presser bar lifter hinge screw.
9. Presser bar spring bracket pinch screw.
10. Presser bar spring bracket.
11. Presser bar, lifting.
12. Presser bar bushing.
13. Lifting presser bar foot screw.
14. Lifting presser bar foot.
15. Vibrating presser bar thumbscrew.
16. Needle bar rock frame hinge stud.
17. Needle bar rock frame.
18. Vibrating presser bar spring.
19. Tension release slide spring.
20. Vibrating presser bar connecting link.
21. Needle bar connecting stud pinch screw.
22. Needle bar rock frame position bracket screw.
23. Vibrating presser bar.
24. Vibrating presser foot.
25. Needle bar.
26. Needle bar thread guide.

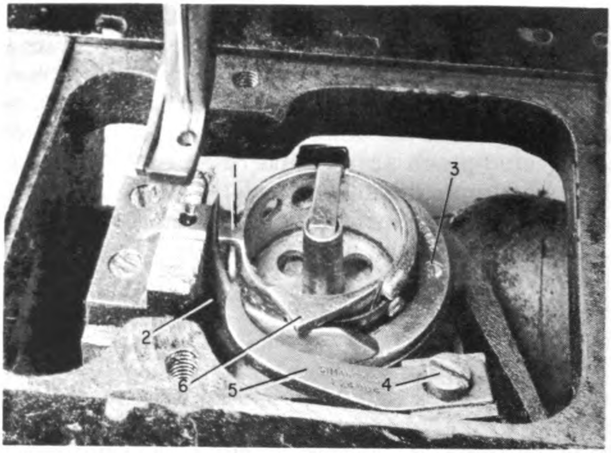


Figure 11-8.—Bobbin case installed in hook.

1. Bobbin case lug.
2. Hook guard washer (needle guard).
3. Hook gib screws.
4. Bobbin case opener screw.
5. Bobbin case opener.
6. Bobbin case projection.

Tap the hook saddle to the right or left as required to bring the hook as close to the needle as possible without touching it. Retighten the screws.

The function of the hook guard washer (needle guard), which is attached to the bottom of the sewing hook, is to prevent the point of the hook from striking the needle if the needle is deflected toward the hook when passing through the material.

The needle guard can be bent with a small pair of pliers until it prevents the hook point from striking the needle, but it should not be bent outward enough to deflect the needle from its normal path.

If setting the hook closer to the needle throws the hook out of time with the needle, retime the hook.

REMOVING, CLEANING, AND REPLACING BOBBIN CASE.—The bobbin case may be removed from the hook without taking the hook out of the machine. To remove the bobbin case, proceed as follows:

Remove the bed slide, throat plate, and feed dog to reveal the parts shown in figure 11-8. Remove the bobbin case opener by taking out the screw (4).

Remove the hook gib by removing the two screws which hold it to the body of the hook. The gib and screws removed from the machine appear in figure 11-9. Lift the bobbin case out of the hook body. Clean the bobbin case with dry-cleaning solvent or diesel fuel oil. Gasoline must not be used for this purpose.

After the bobbin case and hook gib have been replaced, replace the throat plate so that the bobbin case lug fits into the slot in the bottom side of the throat plate. Then replace bobbin case opener.

The bobbin case opener should be adjusted so that it permits the needle thread to pass the triangular projection on the bobbin case and then between the bobbin case lug and the bottom of the throat plate.

RAISING OR LOWERING FEED DOG.—The normal adjustment of the feed dog is as follows: It should rise

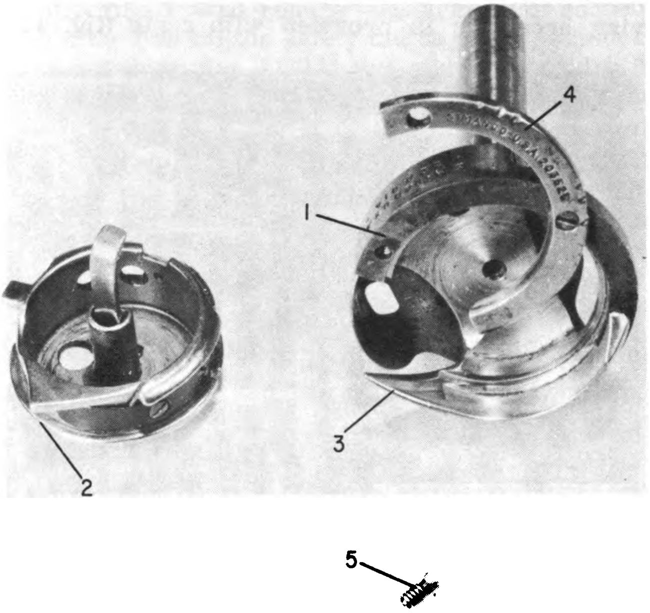


Figure 11-9.—Hook removed from machine and disassembled.

1. Hook body only.	4. Hook gib.
2. Bobbin case complete.	5. Hook gib screw.
3. Point of hook.	

no higher than the depth of the teeth above the throat plate when at its highest position.

To adjust the feed dog, remove the throat plate, clean all lint and dirt from the teeth of the feed dog, replace the throat plate, tip the machine back on its hinges, and turn the balance wheel forward until the feed dog rises to its highest position.

Loosen the feed lifting cam fork screw. Raise or lower the feed bar as necessary to make the feed dog stand the distance of a tooth above the throat plate when the dog is at its highest position. Tighten the feed lifting cam fork screw when the proper adjustment is accomplished.

When this adjustment is made, be careful that the underside of the feed dog does not drop low enough to strike the sewing hook.

ADJUSTING FEED DRIVING ECCENTRIC.—The feed driving eccentric is provided with a gib (fig. 11-10),

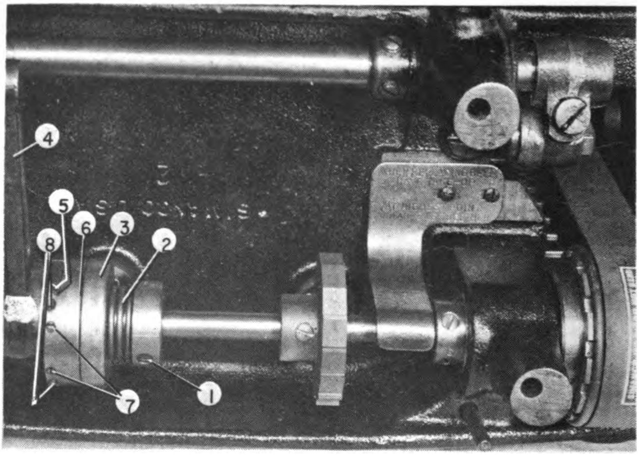


Figure 11-10.—Feed driving eccentric assembly.

1. Feed driving eccentric flange spring collar.
2. Feed driving eccentric flange spring.
3. Feed driving eccentric flange.
4. Feed driving connection.
5. Feed driving eccentric friction gib.
6. Feed driving eccentric body.
7. Feed driving eccentric friction gib adjusting screws.
8. Feed driving eccentric friction gib adjusting screw setscrews.

which can be adjusted to take up any wear or loose motion between the feed driving eccentric and the feed driving eccentric body.

To adjust the gib, loosen the two locking screws (8) near the ends of the gib. Then tighten the setscrews (7) until all play is eliminated and the eccentric fits snugly in the slot in the eccentric body or flange. Be certain to retighten the locking screws.

The adjusting spring (2) presses against the feed eccentric flange to prevent it from moving out of position. If the setscrews in the collar (1) are loosened, the collar may be moved to the right or left to change the pressure. The collar should be set so that the pressure of the spring holds the flange in firm contact with the feed eccentric body (6).

REMOVING AND REPLACING ARM SHAFT CONNECTION BELT.—To remove the arm shaft connection belt, slip the belt off the safety clutch pulley, remove the bearing setscrew (fig. 11-11), and slide the bearing from the arm casting. Remove the belt through the space normally occupied by the arm shaft bearing.

To replace the belt, work it through the space normally occupied by the arm shaft bushing and draw the belt down into the rise of the arm and over the arm shaft connection belt pulley. Replace the bearing with the oil hole up, and tighten the bushing setscrew. Replace the balance wheel, and tighten the balance wheel setscrew. Replace the balance wheel adjusting screw. Turn the balance wheel forward until the thread take-up lever is at its highest point and set the timing arrows as previously explained. Slip the connection belt over the safety clutch pulley.

REMOVING AND ADJUSTING TENSION AND THREAD CONTROLLER.—The tension and thread controller is composed of two tension controlling components, one assembled on the tension stud and the other on the thread controller stud. (See fig. 11-12.) The spring and discs on the tension controller place tension on the thread when the presser foot is down. The spring in the thread controller pulls slack out of the thread between the time the thread take-up lever starts down and the needle point reaches the material.

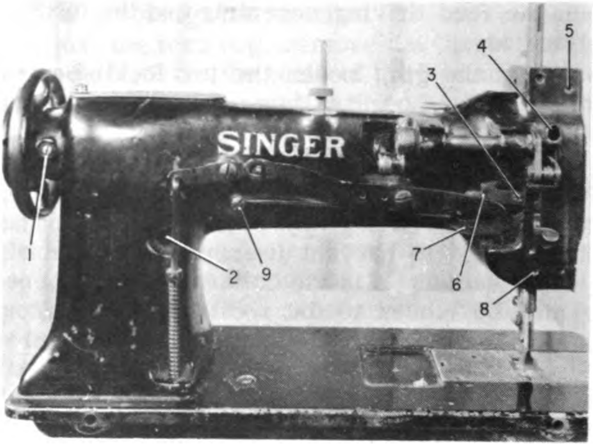


Figure 11-11.—Rear view of sewing machine head.

1. Arm shaft bearing setscrew.
2. Hole in back of arm for reaching the needle bar rock frame rock shaft crank pinch screw.
3. Presser bar lifting bracket pinch screw for holding bracket.
4. Hole in back of face for reaching the presser bar position guide lever pinch screw.
5. Presser bar position guide setscrew.
6. Presser bar lifting releasing lever bracket guide screw.
7. Presser bar flat spring.
8. Presser bar bushing setscrew.
9. Presser bar spring support screw.

The tension controller is adjusted with the thread controller stud. The spring stop is adjusted by loosening the screw and moving the stop to the right or left as necessary to stop the action of spring as the needle enters the material. The amount of the tension will vary with the kind of thread being used.

CLASS 112 SEWING MACHINES

This section contains information necessary for the maintenance and repair of the two-needle sewing machine, Model 112 W 116, shown in figure 11-13. Although these instructions are primarily for use with the Model

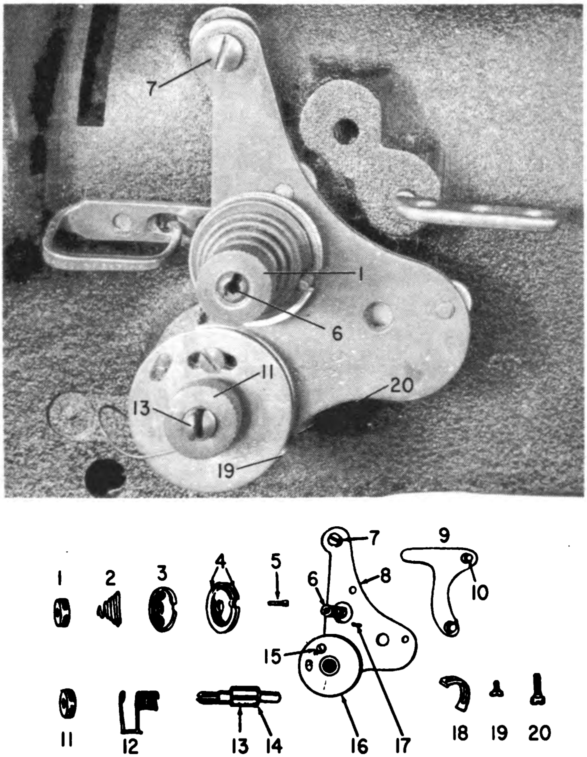


Figure 11-12.—Tension and thread controller installed and disassembled.

1. Tension thumb nut.
2. Tension spring.
3. Tension release washer.
4. Tension discs.
5. Tension release rod.
6. Tension stud.
7. Tension bracket screw.
8. Tension bracket.
9. Tension release lever.
10. Tension release lever screw.
11. Thread controller stud thumb nut.
12. Thread controller spring.
13. Thread controller stud.
14. Thread controller stud washer.
15. Thread controller disc screw.
16. Thread controller disc.
17. Tension disc position pin.
18. Thread controller spring stop.
19. Thread controller spring stop screw.
20. Thread controller stud setscrew.

112 W 116 only, the similar construction of all class 112 machines permits the application of the maintenance and repair procedures to other machines of this class.

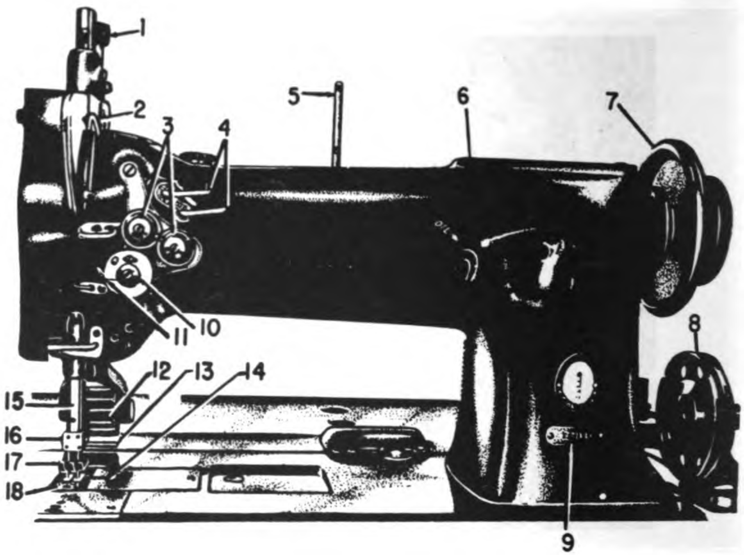


Figure 11-13.—Model 112 W 116 sewing machine.

1. Puller feed roll bar position lever.
2. Thread take-up lever.
3. Thread tension discs.
4. Thread retainers.
5. Thread guide.
6. Arm cap.
7. Balance wheel.
8. Bobbin winder pulley.
9. Model number plate.
10. Thread controller disc.
11. Thread controller spring.
12. Puller feed roll (upper).
13. Puller feed roll (lower).
14. Feed dog.
15. Needle bar.
16. Needle holder.
17. Presser foot.
18. Throat plate.

Sewing Machine 112 W 116

Machine 112 W 116 has two needles and two belt driven rotary hooks and is designed for simultaneously making two parallel lines of lockstitching in fabrics. The distance between the needles may be from 3/32 to 2 inches, as ordered. The machine is equipped with a puller feed in addition to a needle feed and drop feed, and is therefore especially adapted for use in the manufacture and repair of bulky work such as tents, awnings, balloons, flags, etc. It is also used for attaching collars to flight jackets and jumpers, and for general stripping operations on heavy work.

The maximum speed recommended for sewing machine 112 W 116 is 2,800 stitches per minute. Run the machine slower than the maximum recommended speed until the parts which are in movable contact have become glazed by their action upon each other. When a machine is in operation, the balance wheel should always turn over toward the operator.

Needles for sewing machine 112 W 116 are of class and variety 126 x 9, sizes 10 through 24.

The size needle to be used should be determined by the size of the thread which must pass freely through the eye of the needle. If rough or uneven thread is used or if it passes with difficulty through the eye of the needle, the machine will not perform satisfactorily.

Power Unit

The 112 W 116 sewing machine is powered by a 210-230 volt, 60-cycle, 1/3-horsepower, alternating-current electric transmitter. The transmitter is mounted at the rear of the machine stand under the stand top and is belted to the balance wheel. A foot treadle regulates the speed of the machine by means of a clutch assembly on the motor drive shaft.

Line of Power

The major assemblies for the feeding of the material and the stitching of seams derive their power from the arm shaft which is connected to the balance wheel. Proper operation, maintenance, and repair of the Model 112 W 116 sewing machine are based upon an understanding of the line of power and the interrelation of all components.

In the following list, the sequence in line of power to each major assembly is in the order listed. The item numbers on the right refer to the components in figure 11-14.

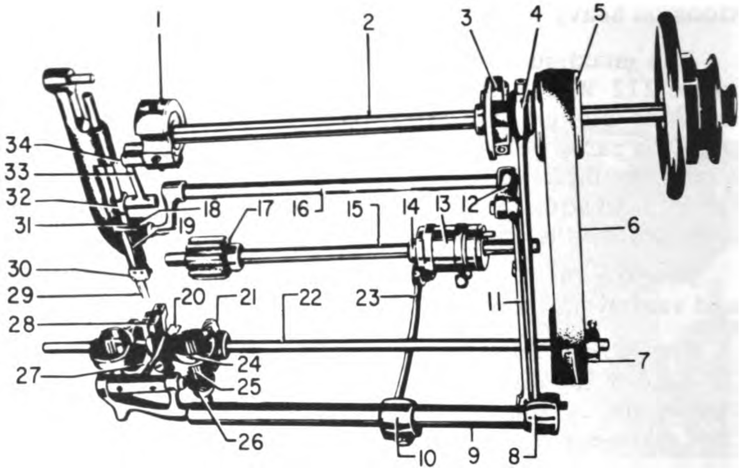


Figure 11-14.—Line of power for Model 112 W 116 sewing machine.

1. Needle bar crank.
2. Arm shaft.
3. Feed driving eccentric regulating bracket.
4. Feed driving connection.
5. Arm shaft connection belt pulley.
6. Arm shaft connection belt.
7. Hook driving shaft pulley.
8. Feed driving rock shaft crank.
9. Feed driving rock shaft.
10. Puller feed clutch driving crank.
11. Needle bar rock frame rock shaft crank connection.
12. Needle bar rock frame rock shaft crank.
13. Puller feed clutch.
14. Puller feed clutch driving flange.
15. Puller feed roll shaft.
16. Needle bar rock frame rock shaft.
17. Puller feed roll (lower).
18. Needle bar rock frame slide block.
19. Needle bar rock frame.
20. Feed lifting cam fork.
21. Hook driving gears.
22. Hook driving shaft.
23. Puller feed clutch driving connection.
24. Hook assembly.
25. Hook socket.
26. Hook socket gears.
27. Feed bar.
28. Feed dog.
29. Needles.
30. Needle holder.
31. Needle bar.
32. Needle bar connecting stud.
33. Needle bar connecting link.
34. Needle bar connecting link stud.

1. NEEDLE BAR ASSEMBLY.
Arm shaft (2)
Needle bar crank (1)
Needle bar connecting link stud (34)

Needle bar connecting link (33)
Needle bar connecting stud (32)
Needle bar (31)
Needle holder (30)
Needles (29)

2. NEEDLE BAR ROCK FRAME ASSEMBLY.
Arm shaft (2)
Feed driving eccentric regulating bracket (3)
Feed driving connection (4)
Feed driving rockshaft crank (8)
Needle bar rock frame rockshaft crank connection (11)
Needle bar rock frame rockshaft crank (12)
Needle bar rock frame rockshaft (16)
Needle bar rock frame slide block (18)
Needle bar rock frame (19)

3. HOOK ASSEMBLY.
Arm shaft (2)
Arm shaft connection belt pulley (5)
Arm shaft connection belt (6)
Hook driving shaft pulley (7)
Hook driving shaft (22)
Hook driving gears (21)
Hook socket gears (26)
Hook socket (25)
Hook assembly (24)

4. FEED DOG ASSEMBLY. Vertical movement of the feed dog is derived from the feed lifting cam which carries the feed lifting cam fork (20). The forward movement of the feed dog is derived from the following line of power:

Arm shaft (2)
Feed driving eccentric regulating bracket (3)
Feed driving connection (4)
Feed driving rock shaft crank (8)
Feed driving rockshaft (9)
Feed bar (27)
Feed dog (28)

5. PULLER FEED ASSEMBLY.
Arm shaft (2)
Feed driving eccentric regulating bracket (3)
Feed driving connection (4)
Feed driving rock shaft crank (8)

Feed driving rock shaft (9)
Puller feed clutch driving crank (10)
Puller feed clutch driving connection (23)
Puller feed clutch driving flange (14)
Puller feed clutch (13)
Puller feed roll shaft (15)
Puller feed roll (lower) (17)

Adjustments and Repairs

It is very important that the operator of a sewing machine be instructed in locating any trouble that might develop during operation, and either effect a remedy or report it to the responsible person.

Major adjustments consist of timing and setting the machine, or adjusting it so that each assembly completes its function in proper relation to the movement of the other assemblies. Once the timing is set, a machine will normally require no further adjustment unless major repairs, such as the replacement of damaged parts, require the stripping of some assemblies.

In order to accomplish proper settings, adjustments, and general performance of any sewing machine, there must be proper tension on the drive belt. The drive belt, connecting the motor clutch pulley to the balance wheel, drives the sewing machine by a friction grip on the belt grooves.

If the belt is too loose, the friction will not be great enough to hold the belt against the balance wheel and the belt will slip and thus wear out quickly. If the belt is too tight, the tension will tend to pull the motor drive shaft off center and the motor bearings will burn out.

A belt tension adjusting screw is mounted on the motor bracket just above the front of the motor. To tighten the belt tension, turn the adjusting screw outward (counterclockwise); to loosen the belt tension, turn the adjusting screw inward (clockwise).

SETTING NEEDLE BAR.—The needle bar must be properly set so that a small loop of thread will form beneath the throat plate as the hook passes the needle. If the needle bar is too high, it will rise too soon and pull the thread loop out of the path of the sewing hook. If the needle bar is too low, it will not rise soon enough and fail to form a loop before the sewing hook passes.

The needle bar is adjusted as follows:

See that both needles are inserted in the needle holder as far as they will go. Turn the balance wheel forward until the needle bar reaches its lowest point. Remove the faceplate, and loosen the needle bar connecting stud pinch screw. (See fig. 11-15.)

If the needle bar is marked, set it so that the upper mark is just visible at the bottom of the needle bar bushing at the lower end of the needle bar rock frame. Marked needle bars are etched with two lines across the bar about 2 inches above the lower end.

If the needle bar is not marked, turn the balance wheel forward until the point of the sewing hook is directly in line with the needle. Then raise or lower the needle bar until the needle eye is 1/16 inch below the hook. Tighten the needle bar connecting stud pinch screw and replace the faceplate.

TIMING SEWING HOOKS.—When the needle bar rises 3/32 inch from its lowest point, the slack in the needle thread forms a loop beside the needle, below the throat plate. The sewing hook should pass alongside the needle 1/16 inch above the eye and catch the loop of the needle thread.

Adjust the timing of the sewing hooks with the needles as follows:

Remove the throat plate and turn the balance wheel forward until the needle bar rises 3/32 inch from its lowest position. On marked needle bars, the lower mark will be just visible below the bushing in the lower end of the needle bar rock frame.

Tilt the machine back to expose the assemblies under the bed of the machine as shown in figure 11-16. Loosen the two screws in each hook shaft gear (6). Turn the sewing hooks until the point of each hook is at the center of its respective needle. Retighten the setscrews in the hook shaft gears, leaving just enough play between the hook shaft gears and the hook driving gears to permit lubrication.

SETTING SEWING HOOKS.—Sewing hooks should cross the needles as closely as possible without touching the needles. Sewing hooks that are too close may strike the needles and break the needles and hooks. Sewing

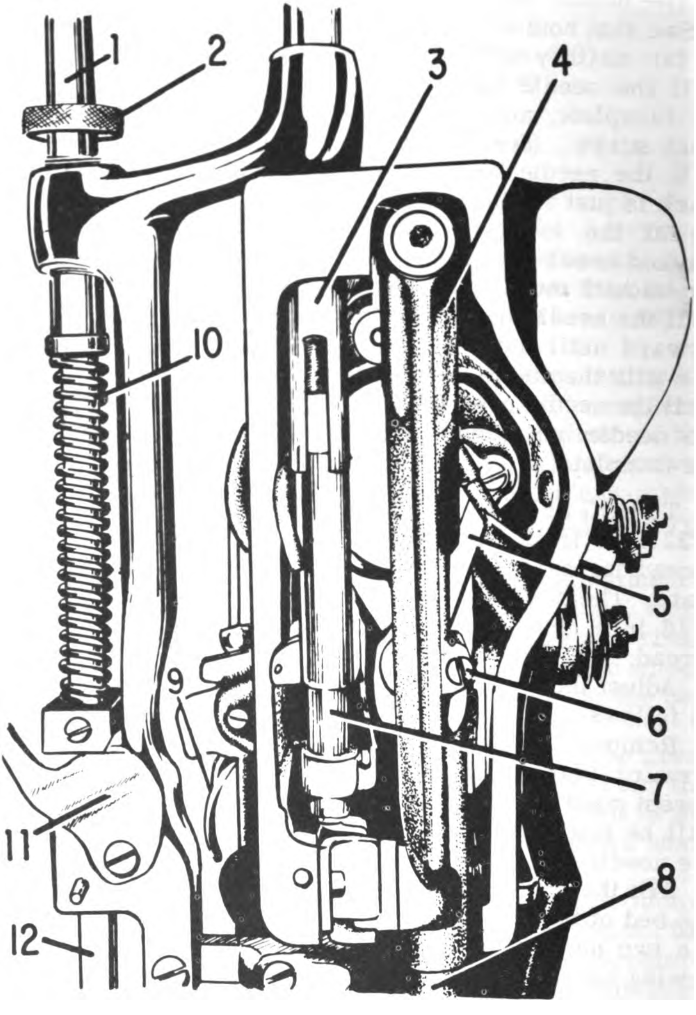


Figure 11-15.—Face assemblies.

1. Puller feed roll bar.
2. Puller feed roll bar thumbscrew.
3. Presser bar position guide.
4. Needle bar rock frame.
5. Needle bar connecting link.
6. Needle bar connecting stud pinch screw.
7. Presser bar.
8. Needle bar.
9. Presser bar lifter.
10. Puller feed roll bar spring.
11. Puller feed roll bar lifter.
12. Puller feed roll bar.

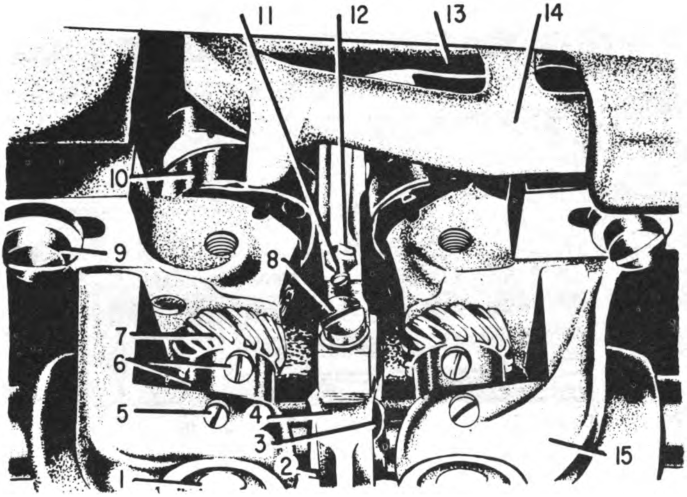


Figure 11-16.—Hook and feed dog assemblies under machine bed.

1. Sewing hook shaft (left).	9. Hook saddle screw.
2. Feed lifting cam.	10. Hook.
3. Feed lifting cam oiling felt.	11. Feed dog tilting adjusting screw.
4. Feed lifting cam fork.	12. Feed dog tilting adjusting screw locknut.
5. Hook bushing setscrew (lower).	13. Feed bar.
6. Hook pinion gear setscrews.	14. Feed driving rock shaft.
7. Hook pinion gear.	15. Hook saddle.
8. Feed lifting cam fork screw.	

hooks that are not close enough may miss the thread loops entirely or split the strands of the threads.

Adjust the sewing hooks to or from the needles as follows:

Turn the balance wheel forward until the points of the sewing hooks are at the center of the needles. Tilt the machine back to expose the assemblies of the bed as shown in figure 11-17.

Loosen the hook saddle screw (7) and the hook saddle pinch screw (21) and move the hook to the left or right as required for proper clearance between the hook and needle. Each hook will have to be individually adjusted for each right or left needle. After setting the hooks

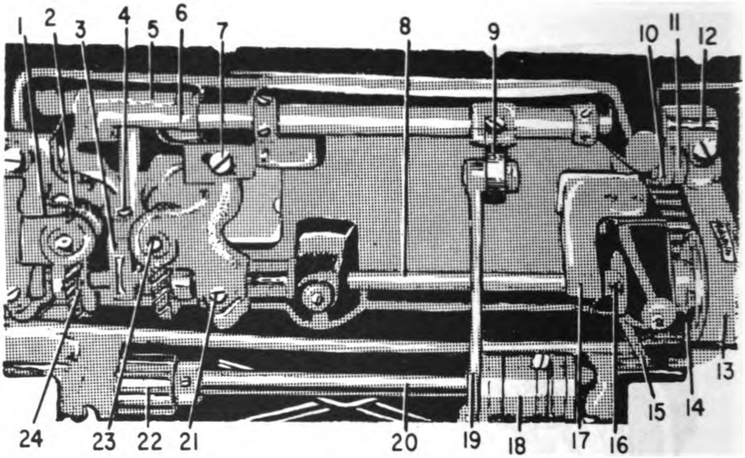


Figure 11-17.—Bed assemblies.

1. Hook saddle.	14. Hook driving shaft pulley.
2. Hook pinion gear.	15. Knee lifter connection lever lifting rod.
3. Feed lifting cam fork.	16. Connection belt timing collar.
4. Feed lifting cam fork screw.	17. Arm shaft connection belt timing plate.
5. Feed bar.	18. Puller feed clutch assembly.
6. Feed driving rock shaft.	19. Puller feed clutch driving connection.
7. Hook saddle screw.	20. Puller feed roll shaft.
8. Hook driving shaft.	21. Hook saddle pinch screw.
9. Puller feed clutch driving crank.	22. Puller feed roll (lower).
10. Needle bar rock frame rock shaft crank connection.	23. Sewing shaft.
11. Feed driving connection.	24. Hook driving gear.
12. Feed driving rock shaft crank.	
13. Arm shaft connection belt.	

properly, tighten the hook saddle and pinch screws and return the machine to operating position.

If the needle is deflected toward the hook, bend the hook guard washer. The hook guard washer is the black steel curved plate on the side of the hook assembly directly under the point of the hook. Bending the washer slightly outward will prevent the needle from striking the hook.

RAISING AND LOWERING FEED DOG.—The feed dog rises from beneath the throat plate to help push the material through the machine. Normal sewing conditions require that when the feed dog rises to its full height, it will show the full length of the teeth above the throat plate.

Raise or lower the feed dog as follows:

After all lint and dust have been cleaned from between the teeth of the feed dog, turn the balance wheel forward until the feed dog has reached its highest position. Loosen the screw in the feed lifting cam fork and raise or lower the feed lifting cam fork as necessary.

Various types of material may require that the feed dog be tilted as well as raised or lowered. To tilt the feed dog, loosen the locknut and turn the feed dog tilting adjusting screw as necessary.

TIMING FEED DOG.—Timing the feed dog for the 112 W 116 sewing machine is accomplished in the same manner as was described for the 111 W 151 machine. (See fig. 11-5.)

SETTING NEEDLE BAR WITH THE PRESSER BAR.—The backward travel of the needle bar rock frame should be set so as to prevent the needles from striking the edge of the presser foot while pushing the material through the machine. The normal gap between the presser bar and the needle bar should be 17/32 inch, measured between the two bars just above the needle holder.

Set the needle bar with the presser bar as follows:

Turn the feed regulating spindle head clockwise until there is no feed movement of the needle bar, rock frame, or feed dog (0 stitches), when the balance wheel is turned over. Turn the balance wheel over until the needle bar reaches its lowest point.

Insert a screwdriver into the access hole in back of the upright machine arm and loosen the needle bar rock frame rock shaft pinch screw. While the screw is loose, move the needle bar rock frame forward or backward as necessary until the distance between the needle bar and presser bar is 17/32 inch. A gage or piece of metal 17/32 inch wide may be used to determine the correct distance.

After adjustment, tighten the needle bar rock frame rock shaft pinch screw and reset the feed regulating spindle head for the desired number of stitches.

ADJUSTING THE FEED REGULATOR.—The feed regulator determines the number of stitches to the inch or the length of the stitch. When the feed regulating spindle head (fig. 11-18) is turned, the feed driving eccentric regulating bracket moves the feed driving rock shaft crank farther off center from the arm shaft and thus changes the amount of forward travel of the feed dog. The distance that the feed dog travels, in turn, determines the length of the stitch or the number of stitches to the inch.

To lengthen or shorten the stitch, turn the feed regulating spindle head, located at the hub of the balance wheel, until the figure representing the desired number of stitches per inch shows in the notch in the balance wheel hub. This automatically adjusts the travel of the feed dog to provide the given number of stitches per inch. The numbers indicating stitches per inch on the spindle head range from 6 to 32.

If the number shown in the balance wheel notch does not correspond to the actual number of stitches per inch that the machine sews, adjust the feed regulator as follows:

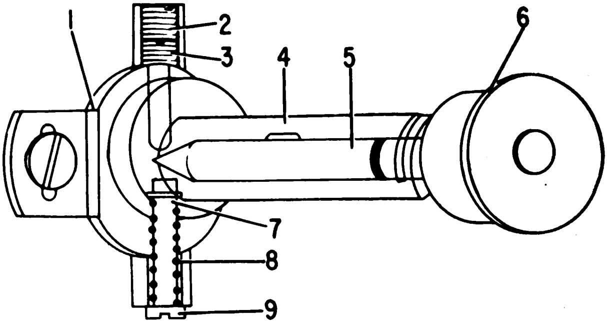


Figure 11-18.—Feed regulator and feed driving eccentric.

1. Feed driving eccentric regulating bracket.
2. Feed driving eccentric regulating screw check screw.
3. Feed driving eccentric regulating screw.
4. Arm shaft.
5. Feed regulating spindle.
6. Feed regulating spindle head.
7. Feed driving eccentric regulating bracket plunger.
8. Feed driving eccentric regulating bracket plunger spring.
9. Feed driving eccentric regulating bracket plunger spring stop screw.

Remove check screw (2) from the feed driving eccentric. Set the feed regulating spindle head so that the number "8" shows in the balance wheel notch.

Sew a few stitches on a scrap of material and count the number of stitches per inch. Turn the balance wheel forward until the feed dog is at its highest position, full length of its teeth showing above the throat plate. Turn the feed driving eccentric regulating screw (3) about 1/4 turn. If the number of stitches that the machine is actually sewing is less than eight, turn the regulating screw outward; if the number is more than eight, turn the screw inward. Continue to sew stitches and repeat the adjusting procedure until the machine is sewing exactly eight stitches per inch. Replace the check screw and tighten securely. The feed regulator will then be automatically set for the full range of stitches per inch.

SETTING SPEED OF PULLER FEED ROLLS.—The puller feed rolls maintain a slight tension on the material, thus aiding in the sewing of a straight, even seam and relieving the needles of much of the feeding pressure. The tension on the upper puller feed roll is maintained by the puller feed roll bar spring. The pressure should be only enough to enable the feed rolls to pull evenly on the material.

To adjust the pressure on the upper puller feed roll, turn the thumbscrew downward to increase the pressure, and upward to decrease the pressure.

As the needle bar and the feed dog push material through the machine, the puller feed rolls turn over to pull on the material. The puller feed rolls should feed the material slightly faster than the drop feed so that the tension on the material between the feed rolls and the drop feed will help to maintain a straight seam.

Change the speed of the puller feed rolls as follows:

Tilt the machine back to expose the assemblies under the bed of the machine. Loosen the puller feed clutch driving crank hinge screw nut that holds the puller feed clutch driving connection to the puller feed clutch driving crank on the feed driving rock shaft.

To increase the speed of the puller feed rolls, slide the driving connection down the slot in the driving crank so that the hinge screw is farther away from the feed driving rock shaft. To decrease the speed, move the connection closer to the shaft. When the desired speed is set, tighten the hinge screw securely and return the machine to operating position.

SETTING THREAD CONTROLLER.—The thread controller consists of a thread controller spring and a thread controller disc. As the needle bar moves downward, the thread controller spring pulls back on the slack thread to prevent the thread from becoming tangled around or under the needle. Tension on the spring may be increased for coarse threads and decreased for fine threads.

Adjust the controller action of the thread controller spring as follows:

Loosen the thread controller spring stop screw. Turn the thread controller spring stop, located behind the tension bracket.

Adjust the tension of the thread controller disc as follows:

Loosen the thread controller stud setscrew. Insert screwdriver into the split end of the thread controller stud. Turn stud to the left to increase the tension and right to decrease the tension. After adjustment, tighten the setscrew securely.

ADJUSTING THE MOTOR CLUTCH.—The clutch assembly utilizes one cork face to drive the clutch plate and another, a split face, to brake the clutch plate. As the toe of the foot treadle is pressed, the clutch shaft is turned inward so that the clutch driven plate (fig. 11-19) is forced up against the clutch pressure face, which is rotating with the motor flywheel. When the heel of the foot treadle is pressed, the clutch driven plate is pulled away from the pressure face and forced up against the brake face. This action stops the assembly from rotating. As the cork faces become worn, the clutch assembly may be tightened to take up the play in the foot treadle and to provide a closer fit between the clutch driven plate and the pressure face. To tighten the clutch assembly, turn the clutch adjusting screw inward.

SEWING MACHINE 31-15

Description

The 31-15 sewing machine, commonly referred to as a tailoring machine, is an oscillating-type machine which

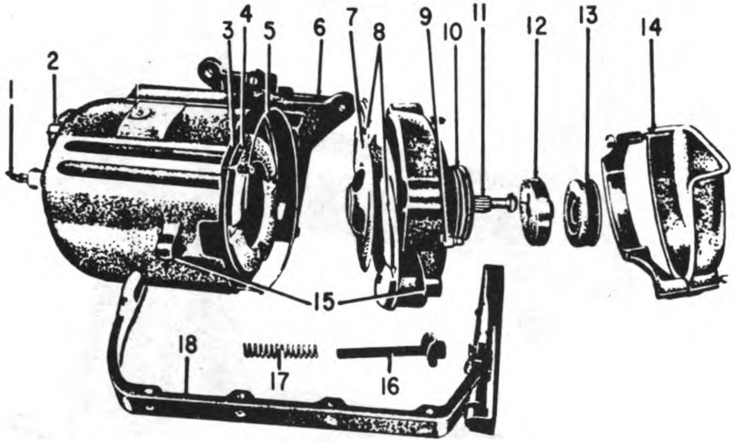


Figure 11-19.—Motor clutch assembly.

1. Motor shaft grease fitting.
2. Motor terminal box.
3. Motor flywheel.
4. Clutch pressure face.
5. Clutch pressure face retaining ring.
6. Motor mounting bracket.
7. Clutch driving plate.
8. Clutch brake face (split).
9. Clutch shaft grease fitting.
10. Motor clutch arm pulley.
11. Clutch shaft.
12. Clutch pulley driving bushing.
13. Clutch pulley.
14. Clutch pulley guard.
15. Clutch adjusting screw brackets.
16. Clutch adjusting screw.
17. Clutch adjusting screw spring.
18. Clutch arm.

makes a lockstitch. It is intended for sewing clothing, is excellent for nylon cloth sewing, and is used for sewing lightweight canvas up to 8 ounces. This machine has a maximum speed of 2,200 stitches per minute. The length of stitches varies from 7 to 32 stitches per inch. The Singer Sewing Machine 31-15 is illustrated in figure 11-20.

Needles for the 31-15 machine are of class and variety 16 x 87. The needles are available in sizes from 14 to 23. The needles vary in size according to the number. The smaller the number, the smaller the needle diameter. Needles do not vary in length within the same class and variety.

TIMING THE NEEDLE WITH SHUTTLE.—When the needle and shuttle are correctly timed, the point of the shuttle on its forward stroke passes across the diameter

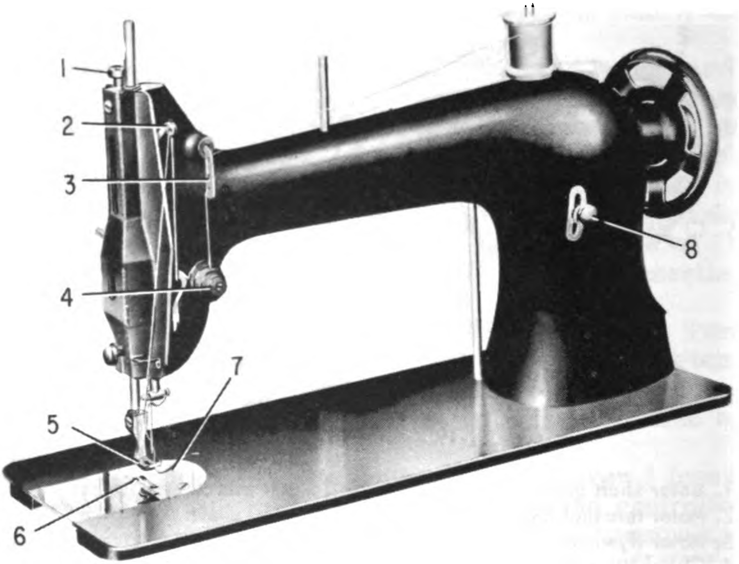


Figure 11-20.—Singer Sewing Machine 31-15.

1. Pressure regulating thumbscrew.
2. Thread take-up lever.
3. Thread retainer.
4. Tension regulating thumb nut.
5. Presser foot.
6. Feed dog.
7. Throat plate.
8. Feed regulator thumbscrew.

of the needle at a point 1/16 inch above the eye of the needle when the needle is on its up stroke.

To time the machine so that the needle and shuttle operate properly (setting needle bar), proceed as follows:

See that the needle is of correct class and variety and that it is pushed up into the clamp as far as it will go. Remove the faceplate and loosen the screw in the needle bar connecting stud. Move the needle bar up or down as may be required to bring the needle eye into correct position when the shuttle point passes across the needle. Tighten the screw, and test the adjustment by observing the operation of the needle and shuttle while the balance wheel is slowly turned by hand.

TIMING THE FEED DOG WITH THE NEEDLE.—If the needle is correctly timed with the shuttle, the feed dog should be on its down stroke and level with the throat plate when the point of the needle reaches the material. If the balance wheel is turned forward, the needle should enter the material. If the balance wheel is turned farther, the needle should enter the material and come back up. After the needle has cleared the material on the upstroke, the feed dog should then rise above the throat plate and push the material forward the distance of one stitch.

To time the feed dog (feed driving eccentric), proceed as follows:

See that the needle is correctly set and timed with the shuttle. Loosen and press the feed regulator thumbscrew to its lowest point. The machine will then make its longest stitch.

Open the round cover plate on the upright, as shown in figure 11-21. Loosen the feed eccentric setscrew. When the setscrew is loosened, the feed dog can be moved without moving the needle. By hand, turn the eccentric until the feed dog has completed its feeding action and is even with the throat plate on the down stroke. With the thread takeup lever at its highest point, retighten the feed

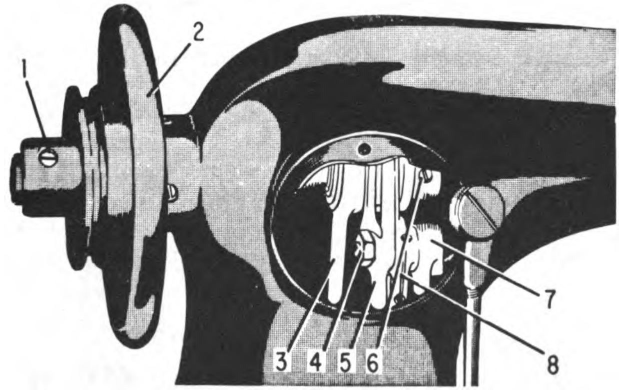


Figure 11-21.—Connecting rods and feed eccentric.

1. Balance wheel setscrew (2).
2. Balance wheel.
3. Feed lifting rock shaft crank connecting rod.
4. Feed regulator hinge screw nut.
5. Feed forked connection (connecting rod).
6. Feed and feed lifting eccentric setscrew.
7. Feed regulator.
8. Feed connecting link.

eccentric setscrew. Test their timing after each adjustment of the feed dog.

RAISING AND LOWERING THE FEED DOG.—The feed dog is normally adjusted for sewing fabrics used in flight clothing, such as jackets, woolen shirts, and pants. When correctly adjusted, it rises just enough for the teeth to show their full length above the throat plate. For sewing extra heavy material (like that in overcoats) or for extra light material, the feed dog may need to be raised or lowered by adjusting the feed lifting rockshaft crank.

Before adjusting the height of the feed dog, see that it is in time with the needle. If the timing is correct, turn the balance wheel forward until the dog reaches its highest point. Loosen the screw on the crank, and adjust the height of the feed dog up or down as desired. Tighten the screw and test the adjustment by hand-turning the balance wheel forward. A change in the height of the feed dog may throw the needle and feed dog out of time. Therefore, check and adjust the timing of the needle and feed dog as necessary.

CLASS 143 SEWING MACHINES

High Speed Sewing Machine 143 W 1

The 143 W 1 has an aluminum alloy vibrating needle mechanism and a rotary hook, and is intended for overseaming and zigzag stitching in fabrics and lightweight leather. It has ball bearings on the rear ends of the arm shaft and hook driving shaft. The speed of 3,500 stitches per minute of this machine is especially valuable in zigzag work. Needles for machine 143 W 1 are of class and variety 135 x 7, sizes are available from 7 to 24.

Adjustments and Repairs on the 143 W 1 Sewing Machine

ADJUSTING THE THREAD CONTROLLER.—The function of the thread controller spring is to hold back the slack of the needle thread until the eye of the needle nearly reaches the material in its descent. Without this controlling action of the spring, the slack thread will

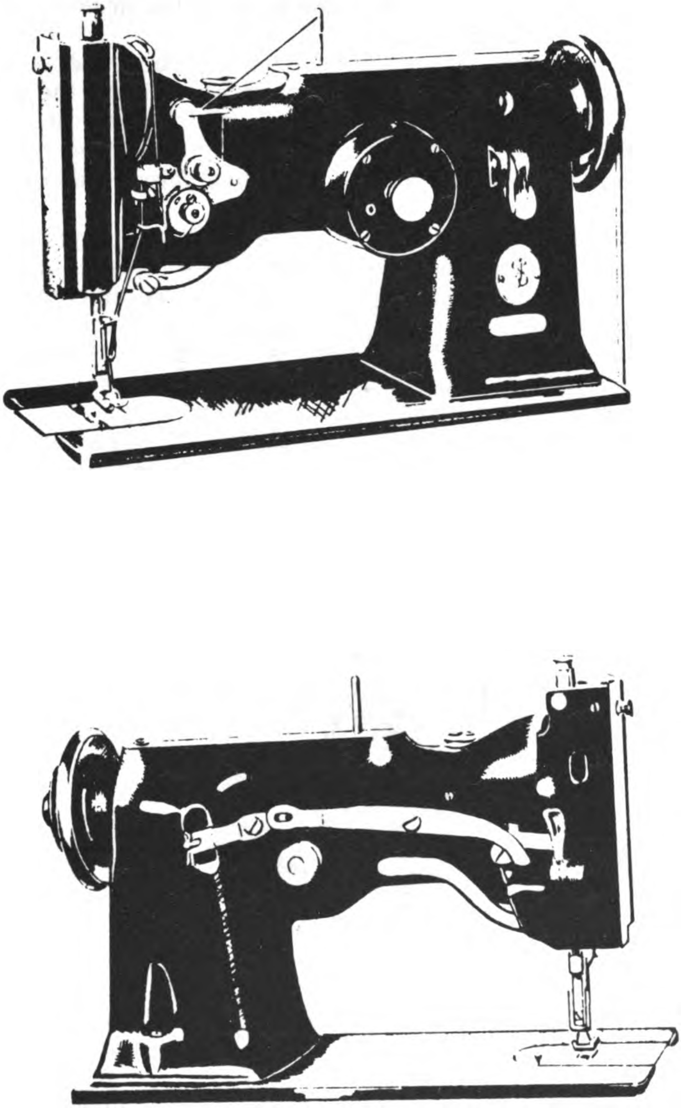


Figure 11-22.—Front and rear view of sewing machine 143 W 1.

sometimes be penetrated by the point of the needle as the needle is descending.

For more controller action on the thread, loosen the stop screw under the controller discs and set the stop lower. (See fig. 11-23.) For less action, set the stop higher. The position of the controller spring (4) is the best average setting for stitching fine fabrics and light leathers.

To strengthen the action of the controller spring on the thread, loosen the tension stud screw (6) and turn the tension stud slightly to the left with a screwdriver. To lighten the spring action, turn the stud to the right. After adjustment, tighten the tension stud screw. A slightly stronger tension is required on this machine than on most other zigzag machines.

SETTING THE NEEDLE BAR FRAME.—To set the needle bar frame, turn the needle vibrator regulating spindle head to the right. This will hold the needle bar frame stationary as for straight stitching. A straight needle should now come in the center of the needle hole in the throat plate. If it does not, loosen the setscrew

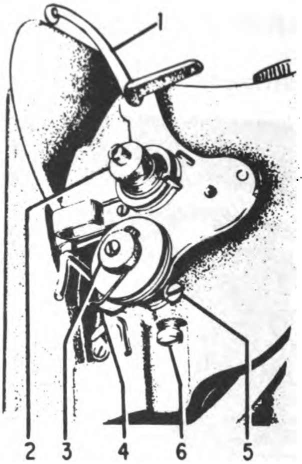


Figure 11-23.—Thread controller.

1. Thread take-up lever.
2. Tension thumb nut.
3. Thread controller stud thumb nut.
4. Thread controller spring.
5. Controller spring stop screw.
6. Tension stud screw.

which secures the eccentric stud, and adjust the stud until it holds stationary. (See fig. 11-24.)

Turn the needle vibrator regulating spindle head to the left for the widest throw. Turn the balance wheel forward until the needle starts upward from its lowest

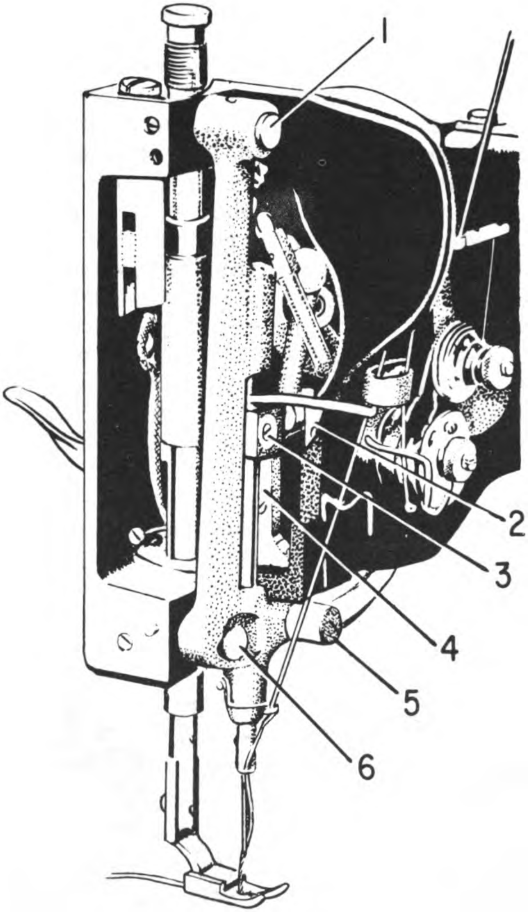


Figure 11-24.—Face assemblies.

1. Arm shaft stud (top).
2. Gib.
3. Needle bar connecting stud setscrew.
4. Gib.
5. Eccentric stud setscrew.
6. Arm shaft stud (bottom).

position. The needle bar frame should start on its sidewise throw at the same time. If it does not, the movement of the needle bar frame may be timed by turning the vibrator gear pinion (fig. 11-25).

SETTING THE NEEDLE BAR.—Before setting the needle bar, see that the needle is of the correct class and variety and is set up as far as it will go into the needle clamp. There are two lines 3/32 inch apart across the needle bar about 2 inches above the lower end. When the needle bar is at its lowest position, the upper mark should be just visible at the lower end of the needle bar frame.

In case the needle bar is not correctly set, loosen the needle bar connecting stud setscrew and move the needle bar to the correct position, then tighten the setscrew.

If the needle bar has no mark, set the needle bar so that when it rises 3/32 inch from its lowest position, the eye of the needle will be about 1/16 inch below the point of the hook as the hook point enters the thread loop.

REMOVING THE ARM SHAFT.—To remove the arm shaft, first remove the arm shaft connection belt. Remove the screw at the center of the balance wheel and loosen the two screws in the belt groove, also the two screws in the belt pulley, and the two in the feed lifting eccentric. Remove the top and bottom studs and the eccentric stud in the needle bar frame after loosening the setscrews that hold them. Remove the needle bar frame. Remove the two gibs which hold the needle bar

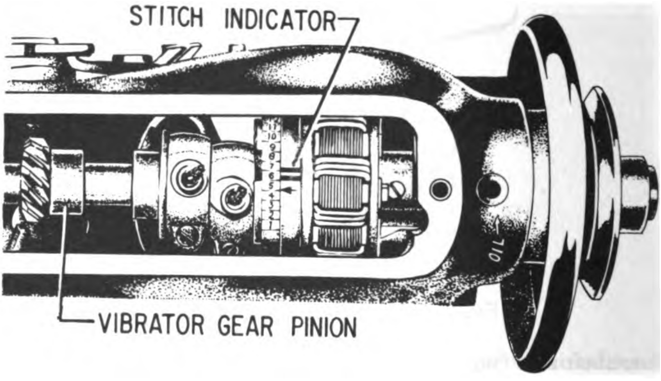


Figure 11-25.—Top of machine.

connecting link in the guide block. Loosen the setscrew which holds the take-up lever stud. Also loosen the spot screw and setscrew in the top of the machine casting, and remove the take-up lever and crank. Loosen the setscrew which holds the front bushing, and withdraw the arm shaft, with the front bushing, from the needle bar end. If the bushing should stick, insert a brass rod through the arm cap hole and drive the bushing out.

REMOVING THE NEEDLE VIBRATOR GEAR SHAFT.—Remove the needle vibrator eccentric bracket cover in front of the arm, loosen the position screws and setscrews in the parts attached to the shaft within the arm. Remove the needle vibrator gear shaft collar at the back of the arm and draw the shaft out.

When replacing these parts, be careful that the large washer is in place between the gear and arm, that the position screws are set firmly against the flat spots on the shaft, and that the setscrews are at the right of the position screws when the shaft has been returned to its place.

SETTING THE NEEDLE VIBRATOR REGULATING SPINDLE HEAD.—Turn the spindle head to the left to make the widest bight possible. Remove the check screw and turn in the adjusting screw until the stitch is of the width desired. (See fig. 11-26.) After adjusting, tighten check screw securely. The width of the stitch may now be decreased by turning the regulating spindle head, but operators cannot make stitches wider than the limit the adjusting screw is set to produce.

This also tends to prevent operators from making a longer stitch than specified, since with a constant width, a longer stitch will have a different shape and may be easily detected.

TIMING THE SEWING HOOK.—When the needle bar is set correctly, loosen the setscrews in the lower belt pulley. Turn the hook as necessary until the point of the hook is opposite the center of the needle.

The hook is set in the same manner as was described for other machines.

CLASS 7 SEWING MACHINES

The Singer Heavy-Duty Sewing Machine Models 7-31 and 7-33 are identical in performance.

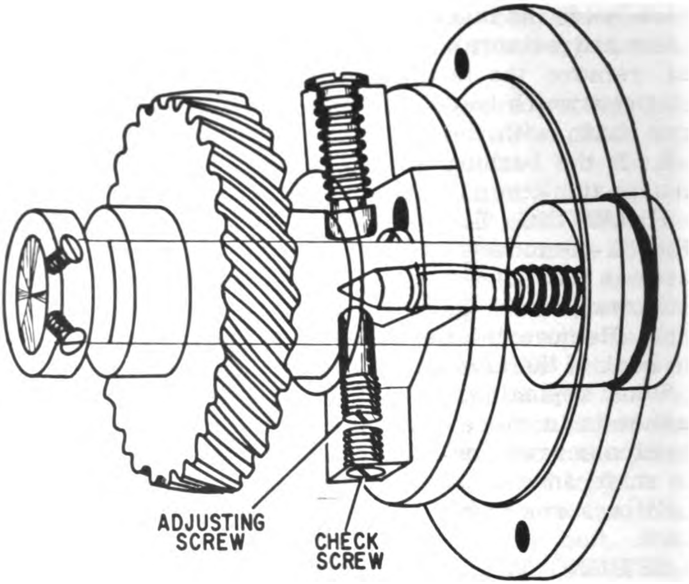


Figure 11-26.—Needle vibrator regulating spindle head.

Description

Class 7 sewing machines are all single-needle lockstitch machines designed for medium and heavy work on canvas, duck, or light leather materials. In parachute maintenance and repair, this machine is used primarily for the sewing of pack trays and webbing.

Model 7-33 sewing machine (fig. 11-27) utilizes a drop feed consisting of alternating presser feet and a feed dog to carry the material through the machine during sewing. The vibrating presser foot and the serrated lugs of the double feed dog move in unison to push the material through the machine with each upstroke of the needle. The lifting presser foot then holds the material in place while the next stitch is being made and while the feed dog and vibrating presser foot move back into position for the next stroke.

Both the 7-31 and 7-33 machines use needles of class and variety 7 x 1 and 7 x 5; sizes available range from 19 to 31. The maximum recommended speed of both machines is 550 stitches per minute.

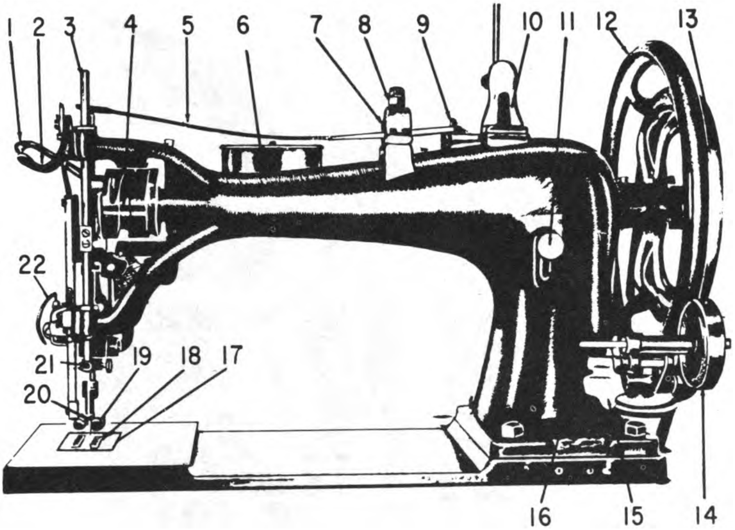


Figure 11-27.—Model 7-33 sewing machine.

1. Thread take-up lever.
2. Lifting presser bar lifter.
3. Needle bar.
4. Thread take-up cam.
5. Vibrating presser bar spring.
6. Oil cup.
7. Vibrating presser bar spring adjusting staple.
8. Vibrating presser bar spring screw.
9. Vibrating presser bar spring stud.
10. Spool holder bracket.
11. Feed regulator thumbscrew.
12. Balance wheel.
13. V-belt.
14. Bobbin winder friction pulley.
15. Bobbin winder stop latch.
16. Bobbin winder spindle.
17. Throat plate.
18. Feed dog.
19. Vibrating presser foot.
20. Lifting presser foot.
21. Needle clamp.
22. Thread guide.

These heavy-duty machines employ a long-beak, oscillating cylinder shuttle which holds the bobbin vertically beneath the throat plate. With each rotation of the arm shaft, the shuttle rotates half a turn and back again. This rotation allows the hook to catch the needle thread, loop it around the bobbin, and thus form the stitch.

Adjustments and Repairs

SETTING NEEDLE BAR.—To set the needle bar, remove the two screws holding the throat plate to the

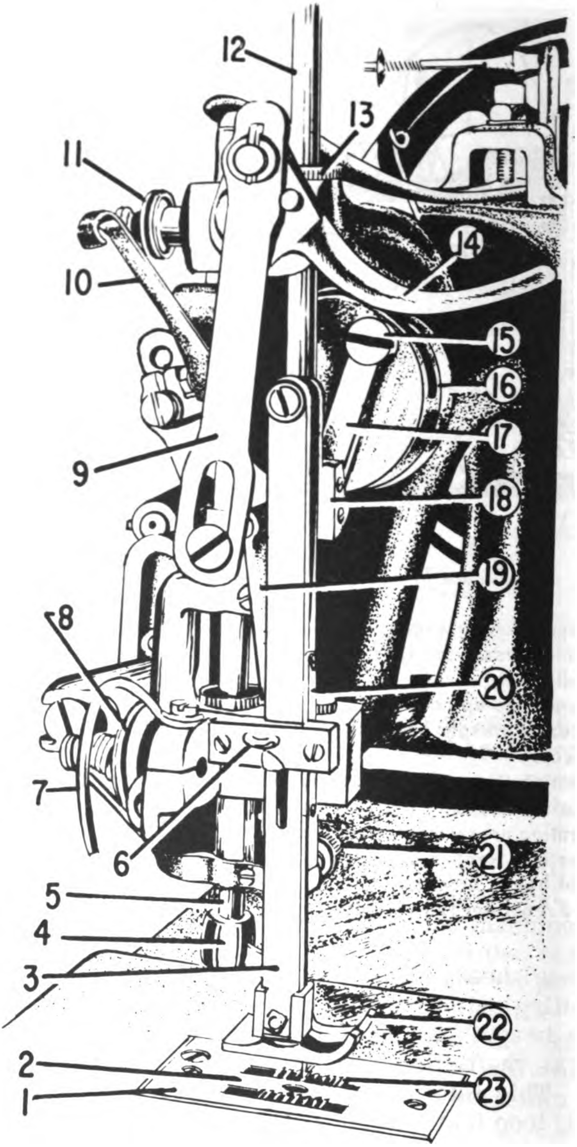


Figure 11-28.—Face assemblies.

Nomenclature for Figure 11-28.

1. Throat plate.
2. Throat plate needle hole strip.
3. Vibrating presser bar.
4. Lifting presser foot.
5. Lifting presser bar.
6. Tension bracket with vibrating pressure bar cap.
7. Thread take-up spring staple.
8. Tension wheel.
9. Lifting presser bar lifting link.
10. Thread take-up lever.
11. Tension discs.
12. Needle bar.
13. Needle bar screw bushing.
14. Lifting presser bar lifter.
15. Needle bar connecting link hinge screw.
16. Thread take-up cam.
17. Needle bar connecting link.
18. Needle bar connecting stud.
19. Vibrating presser bar spring.
20. Vibrating presser bar cushion, rawhide.
21. Needle clamp thumbscrew.
22. Vibrating presser foot.
23. Feed dog.

machine bed, and lift out the throat plate. Turn balance wheel forward until the point of the sewing hook is directly in line with the needle. Loosen the two setscrews in the needle bar connecting stud (fig. 11-28). Raise or lower the needle bar as necessary until the needle eye is 1/32 inch below the point of the hook. Tighten the two setscrews in the needle bar connecting stud.

A simplified method of setting the needle bar is to measure the height of the needle bar above the upper needle bar bushing of a machine that is properly set. This measurement may vary with the type of needle being used in the machine, but with 7 x 1 needles, the height of the bar above the bushing will be approximately 2-3/8 inches when the needle bar connecting stud is at its highest position.

TIMING SEWING HOOK.—The timing of the sewing hook is permanently fixed by the construction of the shuttle assembly. Therefore, if the machine is correctly assembled, no adjustment for timing is required.

SETTING SEWING HOOK.—To set the sewing hook, loosen the shuttle race frame clamping screw and the two setscrews in the oscillating shaft collar beneath the machine bed. (See fig. 11-29.) Move the shuttle race frame (8) slightly to the left or right, as necessary, to bring the point of the hook as close to the needle as possible without touching the needle. Tighten the clamping screw securely and move the oscillating shaft collar up against the frame. Tighten the setscrews in the collar.

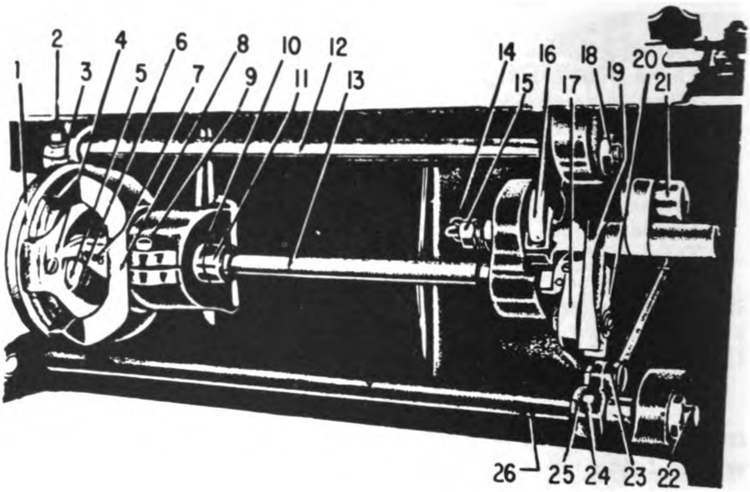


Figure 11-29.—Bed assemblies.

1. Shuttle race.
2. Feed lifting rock shaft crank clamping screw.
3. Feed lifting rock shaft crank.
4. Shuttle race back spring.
5. Bobbin.
6. Shuttle cylinder.
7. Shuttle driver.
8. Shuttle race frame.
9. Shuttle race frame clamping screw.
10. Shuttle race frame.
11. Oscillating shaft collar.
12. Feed lifting rock shaft.
13. Oscillating shaft.
14. Oscillating rock shaft oiling tube.
15. Oscillating rock shaft oiling tube point.
16. Feed lifting rock shaft.
17. Oscillating shaft crank.
18. Feed lifting rock shaft screw center and nut.
19. Oscillating rock shaft.
20. Oscillating shaft crank slide block.
21. Crank connecting rod.
22. Feed rock shaft screw center and nut.
23. Feed forked connection.
24. Feed rock shaft crank clamping screw.
25. Feed rock shaft crank.
26. Feed rock shaft.

RAISE OR LOWER THE FEED DOG.—Loosen the lifting rock shaft crank clamping screw. Turn crank up or down on the feed lifting rock shaft to bring the feed dog to correct height. Tighten the clamping screw securely.

TIMING THE FEED DOG.—To time the feed dog, remove the arm side cover at the back of the machine. Loosen the two setscrews in the feed cam and set the cam for earlier or later movement of the feed dog, as

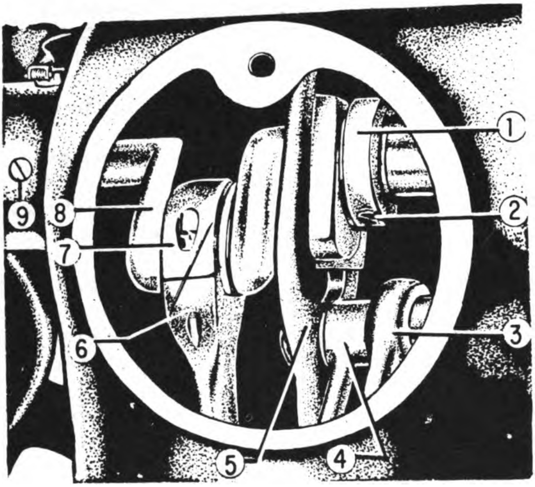


Figure 11-30.—Arm shaft assemblies.

1. Feed cam.
2. Feed cam setscrews.
3. Feed regulator.
4. Feed connecting link.
5. Feed forked connection.
6. Crank connecting rod.
7. Crank connecting rod cap screw.
8. Arm shaft.
9. Arm shaft bushing setscrew.

required, by turning the cam about the arm shaft. (See fig. 11-30.)

Tighten the setscrews and test the feed dog timing by hand-turning the balance wheel. The feed dog should complete its feeding action at the same time that the thread take-up lever completes its upward stroke. When the feed dog is correctly timed, tighten the setscrews in the feed cam and replace the side cover.

Table 11-1.—Troubleshooting chart.

Trouble	Probable Cause	Remedy
Thread breakage	Thread controller.	Adjust spring tension. Adjust spring stop.
	Right twist thread.	Change to left twist.
	Hook point piercing needle thread.	Set hook to needle.
	Needle eye too small.	Select larger size.

Table 11-1.—Troubleshooting chart—Continued.

Trouble	Probable Cause	Remedy
Thread breakage--Cont.	Burr on needle point.	Remove burr.
	Hook out of time.	Retime.
	Too much tension.	Adjust tension springs.
	Improper threading sequence.	Rethread.
	Thread unwinding incorrectly.	Adjust stand and/or spool.
	Thread breaks when clearing work.	Adjust tension release.
		Thread take-up lever not at highest point.
Skipped stitches.	Hook too far from needle.	Move hook saddle.
	Hook out of time.	Retime.
	Needle bar improperly set.	Reset.
	Needle not all the way into bar.	Insert correctly.
	Needle incorrectly aligned.	Insert correctly.
	Thread too large for needle eye.	Select correct needle.
	Hook washer pushing needle.	Adjust washer.
	Thread controller spring out of adjustment.	Adjust tension and stop.
Thread jamming under throat plate.	Operating machine without material.	Unthread when running without material.
	Failure to hold free end of threads for first stitches.	Maintain pressure.
	Bobbin case opener incorrectly adjusted.	Readjust opener.
Thread bunching under material.	Failure to hold free end of threads for first stitches.	Maintain pressure

Table 11-1.–Troubleshooting chart–Continued.

Trouble	Probable Cause	Remedy
Thread bunching under material--Cont.	Needle thread not between tension disc.	Thread disc.
Thread jamming under bobbin case.	Turned balance wheel backwards when needle was threaded. Thread, dirt, line under bobbin case.	Remove jam. Remove case, clean replace.
Stitches not in line.	Insufficient presser foot pressure. Feed dog too low.	Add spring pressure. Set height to one full tooth.
Not stitching as indicated.	Indicating disc loose. Indicating disc incorrectly set. Automatically changing stitches.	Reset and tighten. Reset and tighten. Adjust feed eccentric gib.
Noisy knee lifter.	Spring improperly adjusted. Lifting rock lever rod too close to connection lever rod.	Adjust while operating. Adjust for operating.
Material damaged by scuffing.	Presser foot pressure too great. Feed dog too high.	Regulate pressure. Set one full tooth or less.
Sluggish operation.	Improper oil or accumulation of foreign matter.	Clean with recommended solvent, dry and oil.
Feed failure.	Armshaft not in time with sewing hook driving shaft. Lifting fork inverted.	Retime by take-up lever and timing collar plate. Install properly.

Table 11-1.–Troubleshooting chart–Continued.

Trouble	Probable Cause	Remedy
Feed failure—Cont.	Feed crank pinch screw loose.	Center feed and tighten pinch screw.
	Feed eccentric out of spline.	Reset eccentric.
	Set at negative feed.	Set for stitching.
Failure to make stitch.	Machine out of time.	Inspect and retime.
	Needle threaded from wrong side.	Thread correctly.
	Hook too far away from needle.	Reset hook saddle.
	Wrong variety needle.	Change to correct length.
	Bent needle.	Change.
	Needle not all the way into the needle bar.	Insert correctly.
	Safety clutch disengaged.	Clear jam. Re-engage clutch.
Binds	Alternating pressers improperly set.	Reset to lift equally.
	Bobbin opener set too close.	Set to allow needle thread passage around bobbin case lug.
	Arm shaft friction washer missing.	Install friction washer.
	Balance wheel improperly set for end tolerance.	Tighten adjusting screw, back off 1/4 turn, tap screw with mallet.
	Needle bar too high or too low in frame.	Reset needle bar.
	Eccentric connection against eccentric body.	Set connection flush with cam.
	Hook guard washer rubbing opener lever link.	Replace washer. Adjust hook assembly for tolerance.

Table 11-1.–Troubleshooting chart–Continued.

Trouble	Probable Cause	Remedy
Binds--Cont.	Pinion gear against saddle.	Relocate on hook shaft.
	Driving gear against saddle.	Relocate to center on center line of hook shaft.
	Bobbin case thread jam.	Remove case, clear, reinstall.
	Feed dog against throat plate.	Adjust to proper height. Adjust to center of throat plate.
	Feed bar hinge stud screw.	Adjust for operating tolerance.

SAFETY PRECAUTIONS

Before making any adjustments that may require contact with moving parts, cut off the motor or disconnect the drive belt. This is particularly important when changing needles. If the motor is not disconnected, stepping on the foot treadle will start the machine and may drive needles through the operator's hand or fingers.

While making electrical connections, be careful not to touch bare terminals or wires, since current required to run these sewing machines is usually of sufficient amperage to be dangerous.

Be sure that the balance wheel always turns over toward the operator of the machine. Never turn the balance wheel more than a half turn back. Do not operate a machine without material beneath the presser foot. If it is necessary to test run a machine, remove needles, bobbins, and presser foot, or place a scrap of material beneath the presser foot. Keep the bed slide plates closed while machine is in operation.

SUPPLY

It is the responsibility of the Parachute Rigger in charge of the loft to make it his business to anticipate the loss and damage of certain small parts. All sewing machine parts listed in the supply catalog, with the exception of needles, must be ordered through the Supply Office, using an Open Purchase contract with the respective sewing machine manufacturers. This procedure takes time and is costly, but it is the only method to follow for the replacement or stocking of spare parts.

In order to accurately place an order for sewing machine parts, it is necessary to list the manufacturer, the manufacturer's part number for each item, the nomenclature, and the quantity required. It is also a good practice to mention the type or style of sewing machine for which the parts are intended, in case the manufacturer can substitute a part. This information will help the Supply Officer and will expedite the order.

Carefully follow the manufacturer's instructions for ordering parts. These instructions are found in the manufacturer's parts catalog. Every activity utilizing sewing machines should have a parts catalog for each type machine. Do not wait until something goes wrong before looking for a parts catalog.

QUIZ

1. The bobbin case opener is adjusted
    a. 3/32 inch between the opener and the pointed projection
    b. with no tolerance between the opener and the pointed projection
    c. for the bobbin to be open when the hook is within the needle scarf
    d. so the thread passes freely between the throat plate and the case
2. The purpose of the bobbin case lug is to
    a. hold the bobbin in the bobbin case
    b. prevent the bobbin case from spinning
    c. adjust the bobbin tension
    d. aid the bobbin case opener in its proper function
3. The purpose of the safety clutch is to prevent
    a. needle breakage
    b. damage to machine parts
    c. excessive speed
    d. damage to the mechanical opener

4. When centering the feeding action, it is necessary to have
    a. thread take up lever at highest position
    b. lower timing mark on needle bar just visible
    c. upper timing mark on needle bar just visible
    d. zero feeding action

5. When timing the sewing hook with the needle, the relationship pertaining to distance is
    a. 1/16 inch below the needle eye
    b. 1/16 inch above the needle eye
    c. 1/32 inch above the needle eye
    d. 1/32 inch above the needle scarf

6. By moving the drive gear to the right on the 111 W 151, the sewing hook would be
    a. raised
    b. retarded
    c. lowered
    d. advanced

7. The screws should be loose in the hook saddle of the 111 W 151 to set the
    a. take-up lever
    b. hook with the needle
    c. hook to and from the needle
    d. needle bar

8. Besides using the bell crank when setting an unmarked needle bar the following is also used as a guide:
    a. throat plate
    b. lower side of feed dogs
    c. lower side of feed bar
    d. needle bar rock frame

9. When timing the arm shaft to the hook drive shaft, the guide that must be used is the
    a. thread take-up lever and arrows
    b. bell crank horizontal and zero feed
    c. upper timing mark on needle bar, bar on upstroke
    d. point of hook center of needle 1/16 inch above eye

10. When the feed dog is at its highest position, the teeth should show___________above the throat plate:
    a. 1/4 inch
    b. 1/2 inch
    c. 3/4 inch
    d. 1 full tooth

11. The adjustment point for the thread controller spring tension is the
    a. controller spring stud
    b. thumbscrew on controller spring stud
    c. controller spring stop
    d. controller spring stud setscrew
12. Needle thread strand split is caused by
    a. hook too far from needle
    b. thread controller spring too tight
    c. bent hook guard washer
    d. upper tension too tight
13. When a machine is sewing 8 measured stitches per inch and the stitch indicator is indicating 16,
    a. adjust the feed driving eccentric
    b. adjust the stitch indicator
    c. retime the arm shaft and HDS
    d. retime the sewing hook
14. In the 111 W 151 the feeding action originates in the
    a. feed bar
    b. feed crank
    c. needle bar
    d. feed eccentric
15. What class and variety of needles are used in the 111 W 151 sewing machine?
    a. 16 x 87
    b. 135 x 7
    c. 135 x 17
    d. 7 x 1
16. When setting the needle bar on a 111 W 151, the lower timing mark will be
    a. 1/8 inch below needle bar rock frame
    b. used
    c. disregarded
    d. not visible
17. When setting a marked needle bar, aside from the timing marks, a guide used is
    a. thread take-up lever in its highest position
    b. zero feed
    c. needle bar link vertical and in its lowest position
    d. needle bar link vertical and in its highest position
18. The purpose of the hook guard washer is to prevent the
    a. needle from striking the point of the hook
    b. sewing hook from striking the mechanical opener
    c. sewing hook shaft from slipping in the pinion gear
    d. bobbin case from slipping out of the bobbin race

19. To increase tension the thread controller spring stud is turned
    a. counterclockwise
    b. clockwise
    c. up
    d. down
20. If the needle of a sewing machine is piercing the needle thread
    a. decrease the thread controller spring tension
    b. increase the thread controller spring tension
    c. retime the sewing hook
    d. retime the arm shaft and hook drive shaft
21. When setting the hook to or from the needle, the distance between the needle and the point of the sewing hook should be:
    a. 1/32 inch
    b. as close as possible without touching the needle
    c. barely striking the needle
    d. just close enough to cause the hook guard washer to deflect the needle
22. What class and variety of needles are used in the 31-15?
    a. 135 x 7
    b. 135 x 17
    c. 16 x 87
    d. 126 x 9
23. The front presser on the 111 W 155 is the
    a. lifting presser
    b. vibrating presser
    c. riding presser
    d. alternating presser
24. The distance between the presser bars on the 111 W 155 is____________inch
    a. 17/32
    b. 19/64
    c. 21/64
    d. 3/32
25. Which presser on the 111 W 155 holds the fabric?
    a. Lifting presser
    b. Vibrating presser
    c. Riding presser
    d. Alternating presser
26. Where is the adjustment point for the total lift on the 111 W 155?
    a. Feed driving eccentric
    b. Feed lifting eccentric
    c. Lifting rock shaft crank
    d. Feed lifting cam fork

APPENDIX I

ANSWERS TO QUIZZES

Chapter 1

INTRODUCTION

1. d.
2. d.
3. b.
4. a.
5. b.
6. c.
7. a.
8. c.

Chapter 2

THE PARACHUTE LOFT

1. b.
2. c.
3. d.
4. d.
5. b.
6. b.
7. c.
8. a.
9. b.
10. c.
11. d.
12. b.
13. c.
14. c.
15. b.
16. c.
17. a.
18. b.
19. c.
20. d.
21. a.
22. b.
23. a.
24. c.
25. d.

Chapter 3

TESTING AVIATOR'S BREATHING OXYGEN

1. c.
2. d.
3. a.
4. c.
5. b.
6. b.
7. d.
8. a.
9. d.
10. a.
11. c.
12. b.
13. c.
14. b.
15. c.
16. b.
17. c.
18. b.
19. a.
20. c.
21. a.
22. a.
23. c.
24. b.
25. c.

Chapter 4

REGULATOR TEST STANDS

1. b.
2. a.
3. c.
4. d.
5. b.
6. a.
7. b.
8. b.
9. a.
10. c.
11. a.
12. b.
13. c.
14. a.
15. d.
16. b.
17. b.
18. d.
19. a.
20. c.
21. a.
22. b.
23. d.

Chapter 5

TEST STAND RECALIBRATION

1. d.
2. d.
3. a.
4. c.
5. b.
6. c.
7. c.
8. b.
9. d.
10. a.
11. d.
12. b.
13. d.
14. a.
15. c.
16. a.
17. d.
18. c.
19. a.
20. c.
21. b.
22. b.

Chapter 6

REGULATOR MAINTENANCE

1. b.
2. d.
3. b.
4. c.
5. c.
6. d.
7. d.
8. b.
9. c.
10. a.
11. a.
12. d.
13. c.
14. a.
15. b.
16. a.
17. b.
18. c.
19. c.
20. b.
21. d.
22. c.
23. b.
24. d.
25. c.

Chapter 7

REGULATOR MAINTENANCE--CONTINUED

1. b.
2. c.
3. d.
4. d.
5. b.
6. a.
7. d.
8. a.
9. b.
10. b.
11. a.
12. d.
13. b.
14. c.
15. a.
16. c.
17. c.
18. a.
19. b.
20. b.
21. d.
22. c.
23. b.
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1. a.
2. b.
3. b.
4. a.
5. a.
6. d.
7. d.
8. d.
9. c.
10. b.
11. a.
12. b.

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5. a.
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7. d.
8. a.
9. c.
10. b.
11. b.
12. c.
13. a.
14. c.
15. c.
16. b.
17. d.
18. d.
19. c.
20. d.

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10. c.
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13. b.
14. b.
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23. b.
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6. d.
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9. a.
10. d.
11. a.
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13. b.
14. d.
15. c.
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17. c.
18. a.
19. a.
20. b.
21. b.
22. c.
23. b.
24. c.
25. a.
26. b.

APPENDIX II

QUALIFICATIONS FOR ADVANCEMENT IN RATING

PARACHUTE RIGGER (PR)

(Through Change 12)

General Rating (applicable to PO3, PO2, PO1, and CPO)

Scope

Parachute Riggers inspect, maintain, and repair parachutes, survival equipment, and flight and protective clothing and equipment; pack and rig parachutes; pack and equip life rafts; repair and text oxygen regulators and liquid oxygen converters removed from aircraft; fit and maintain oxygen masks, flight clothing, anti-exposure suits and anti-G suits; test and service pressure suits; operate and maintain carbon dioxide and liquid and gaseous oxygen shop transfer and recharge equipment; operate sewing machines; test safety belts and shoulder harnesses removed from aircraft; and supervise operation of parachute lofts and instruct in the use of survival equipment in association with escape and evasion tactics.

PATH OF ADVANCEMENT TO WARRANT AND LIMITED DUTY OFFICER

Parachute Riggers advance to Warrant, Aviation Operations Technician and/or Limited Duty Officer, Aviation Operations.

Navy Enlisted Classification Codes

For specific Navy enlisted classification codes included within this rating see Manual of Navy Enlisted Classifications, NavPers 15105-A, codes PR—7300 to PR—7399.

Qualifications for Advancement in Rating

1. Qualifications for advancement to a higher rate include the qualifications of the lower rate or rates in addition to those stated for the higher rate.

2. Practical factors will be completed before recommendation for participation in the advancement examinations. (Bureau of Naval Personnel Manual, NavPers 15791, Articles B 2327 and C 7201.)
3. Knowledge factors and knowledge aspects of practical factors will form the basis for questions in the written advancement examinations.
4. To qualify for advancement to Parachute Rigger, Third Class, personnel must have met the physical requirements for student parachute jumpers prescribed in the Manual of the Medical Department and must have made one jump under prescribed conditions using a parachute personally packed under the supervision of a qualified Parachute Rigger.
5. Parachute Riggers must test by actual jump under prescribed conditions any personally packed personnel parachute when directed by proper authority.

Qualifications for Advancement in Rating

Qualifications for advancement in rating	Applicable Rates
	PR
A. SAFETY	
1.0 PRACTICAL FACTORS	
1. Observe safety precautions when working in parachute lofts and shops, handling oxygen and carbon dioxide, and operating sewing machines	3
2. Observe safety precautions in use, handling, and storage of flammable cements, solvents, and thinners	2
3. Observe safety precautions in use of oxygen shop transfer equipment and in handling liquid and gaseous oxygen	1
4. Inspect work areas, tools, and equipment to detect potentially hazardous and unsafe conditions and take appropriate corrective action	C

Qualifications for advancement in rating	Applicable Rates
	PR
A. SAFETY—Continued	
2.0 KNOWLEDGE FACTORS	
None	
B. PARACHUTES	
1.0 PRACTICAL FACTORS	
1. Inspect and pack parachutes; attach and rig equipment, such as pararaft kits and oxygen bail-out units; make entries in parachute record and history cards. (Martin-Baker ejection seat parachutes are removed and installed in aircraft by personnel in the AM rating and delivered to the parachute loft for repacking by the PR rating.)	3
2. Unpack, wash, and dry parachutes	3
3. Identify stains and deterioration of parachute material.	3
4. Make minor repairs to parachutes and component parts	3
5. Instruct plane captains, pilots, and aircrewmen in proper care, handling, and stowage of parachutes	2
6. Test and adjust automatic parachute actuators	2
7. Measure temperature and humidity in parachute dry lockers and storage rooms	1
8. Instruct in the procedures for parachute landings in high winds, trees, and water	C
9. Demonstrate aircraft emergency escape procedures and use of parachutes under simulated conditions	C

Qualifications for advancement in rating	Applicable Rates
	PR
B. PARACHUTES—Continued	
2.0 KNOWLEDGE FACTORS	
1. General arrangement and facilities of parachute lofts, ashore and afloat	3
2. Types, component parts, construction, and operation of personnel parachutes	3
3. Types and operating principles of automatic parachute actuators. .	2
4. Temperature and humidity limitations for parachute dry lockers and storage rooms.	1
5. Purposes and operating principles of drogue, cargo, target drone, and other types of nonpersonnel parachutes	C
C. FABRIC WORK	
1.0 PRACTICAL FACTORS	
1. Hand sew, stitch, and tack material	3
2. Install and replace standard snap fasteners, grommets, slide fasteners, and speedy rivets	3
3. Inspect and proof load safety belts, automatic lap belts, and shoulder harnesses removed from aircraft. (Safety belts, automatic lap belts, and shoulder harnesses are removed and installed in aircraft by personnel in the AM rating.)	3
4. Operate standard sewing machines	3
5. Repair slide fasteners	2
6. Lubricate sewing machines and make minor adjustments	2
7. Cold patch and vulcanize rubberized material	2

Qualifications for advancement in rating	Applicable Rates
	PR
C. FABRIC WORK—Continued	
1.0 PRACTICAL FACTORS--Continued	
8. Make fabric assemblies	2
9. Develop and lay out patterns from drawings, blueprints, and photographs	1
10. Determine causes of sewing machine malfunctions; repair and replace parts	C
2.0 KNOWLEDGE FACTORS	
1. Types and general characteristics of fabrics, tapes, webbings, fasteners, needles, thread, and other material used in fabric work	3
2. Types and uses of seams and stitching patterns	3
3. Operating principles of standard sewing machines	3
4. Types and application of fabric patches	2
5. Procedures for removing stains from fabric materials	2
6. Symbols and terms used on drawings and blueprints for fabric work	1
7. Specifications, characteristics, and uses of fabrics, tapes, webbings, thread, hardware, and other materials used in fabric work and allowable substitutes	C
D. FLIGHT AND PROTECTIVE CLOTHING AND EQUIPMENT	
1.0 PRACTICAL FACTORS	
1. Inspect and test life vests and attached equipment	3
2. Inspect and clean oxygen masks	3

Qualifications for advancement in rating	Applicable Rates
	PR
D. FLIGHT AND PROTECTIVE CLOTHING AND EQUIPMENT—Continued	
1.0 PRACTICAL FACTORS--Continued	
3. Remove and replace components of oxygen mask assemblies including mask-mounted oxygen regulators	3
4. Prepare required records and reports of flight and protective clothing and equipment inspections and maintenance	3
5. Patch life vests and anti-exposure suits	2
6. Repair flight clothing	2
7. Fit integrated torso harness suits	2
8. Fit and repair anti-exposure suits	2
9. Fit and adjust helmets and liners; install earphones and microphones. (Earphones and microphones are maintained by the AT rating.)	2
10. Fit and adjust anti-G suits. (Anti-G systems, except the suit, are maintained by personnel in the AM rating.)	1
11. Operate portable pressure suit leakage test kits; test pressure suits and related components. (Full and partial pressure suits are fitted under the direction of flight surgeons and aviation physiology training units.)	1
12. Fit and modify oxygen masks. . .	C
13. Demonstrate use of flight and protective clothing and equipment under simulated conditions	C
2.0 KNOWLEDGE FACTORS	
1. Use and application of fire retardant compounds for flight clothing	2

Qualifications for advancement in rating	Applicable Rates
	PR
D. FLIGHT AND PROTECTIVE CLOTHING AND EQUIPMENT—Continued	
2.0 KNOWLEDGE FACTORS—Continued	
2. Regulations governing changes and repairs to flight and protective clothing and equipment	2
3. Components and principles of operation of full pressure suits	2
E. SURVIVAL EQUIPMENT	
1.0 PRACTICAL FACTORS	
1. Inspect, test, equip, and pack life rafts; replace carbon dioxide cylinders. (Life raft ejection systems in aircraft are maintained by personnel in the AM rating. Emergency radio signalling units are delivered to the electronic shop for maintenance or exchange by the AT rating.). .	3
2. Operate carbon dioxide recharge equipment	3
3. Patch holes and tears in life rafts	2
4. Demonstrate use of life rafts and equipment	2
5. Maintain carbon dioxide recharge equipment	1
6. Assemble, pack, and rig air drop survival kits and containers . . .	C
2.0 KNOWLEDGE FACTORS	
1. Types, construction, and operation of life rafts	3
2. Principles of operation of carbon dioxide cylinder components used in life rafts	2
3. Construction of various types of lift webs and sling assemblies for use on cargo to be dropped with aerial delivery parachutes	C

Qualifications for advancement in rating	Applicable Rates
	PR
F. OXYGEN EQUIPMENT	
1.0 PRACTICAL FACTORS	
1. Operate and maintain liquid and gaseous oxygen shop transfer equipment. (Personnel in the AM rating service, handle and maintain liquid and gaseous oxygen transfer trailers.)	1
2. Shop test aircraft liquid oxygen converters; repair or replace components as necessary. (Converters are removed and installed in aircraft by personnel in the AM rating and delivered to the oxygen shop for test, repair, or exchange.)	1
3. Test oxygen for contamination, using water vapor indicators, halide detectors, and purity analyzers.	1
4. Test and repair oxygen regulators. (Includes mask mounted, aircraft mounted, and pressure suit regulators. Aircraft mounted regulators are removed and installed in aircraft by personnel of the AM rating and delivered to the oxygen regulator shop for test, repair, or exchange.)	1
5. Prepare appropriate calibration and flow charts for testing oxygen regulators and liquid oxygen converters	C
6. Maintain oxygen regulator test stands and liquid oxygen converter test stands	C
2.0 KNOWLEDGE FACTORS	
None.	

Qualifications for advancement in rating	Applicable Rates
	PR
G. ADMINISTRATION	
1.0 PRACTICAL FACTORS	
1. Inventory and order equipment, spare parts, and material	1
2. Maintain current loft and shop files of applicable technical publications, directives, and manuals	1
3. Prepare reports of test and repair of oxygen regulators	1
4. Maintain loft and shop records of packing, inspection, test, and repair of equipment and material; prepare appropriate reports . . .	1
5. Use NAVAER Publications Index to identify and order technical publications, directives, and manuals	1
6. Organize and administer a parachute loft	C
7. Plan, schedule, and direct work assignments in a parachute loft . .	C
8. Interpret and apply bulletins and technical directives	C
9. Prepare reports for survey of material and equipment	C
10. Instruct and supervise personnel in use of parachute loft equipment and facilities and maintenance techniques; maintain quality control of work performed . .	C
11. Prepare for advanced-base or forward area operation by estimating material, equipment, and manpower requirements for repair and maintenance of parachutes and survival equipment . .	C
12. Instruct in use of survival equipment in association with escape and evasion tactics	C
2.0 KNOWLEDGE FACTORS	
None.	

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* U.S. GOVERNMENT PRINTING OFFICE : 1959 O—512305

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